MDOT
Michigan Department of Transportation

2019 Freeway Congestion & Reliability Report

Chapter 8
UNIVERSITY REGION SUMMARY

PROLOGUE

Since 2014, the Michigan Department of Transportation (MDOT) has used probe vehicle data to create an annual Freeway Congestion and Reliability Report. The probe vehicle data is collected anonymously from GPS enabled devices and in-vehicle telematics to provide real time speeds on roadways nationwide. Probe vehicles provide an enormous amount of data which can be difficult to manage, maintain, and analyze. The University of Maryland Center for Advanced Transportation Technology (CATT) Lab developed a visual analytics platform called the Regional Integrated Transportation Information System, or RITIS. This tool allows MDOT to monitor speeds, incidents, weather, special events, and many other data sources. Using the RITIS platform, data was downloaded, processed, and compiled into a report summarizing all freeway routes in Michigan.

This report is composed of eight chapters. The first chapter summarizes performance measures and statewide metrics. The remaining seven chapters use those performance metrics to characterize congestion in each of MDOT's seven regions. This document is for internal use to help MDOT regions, Transportation Service Centers (TSC), and planners understand how Michigan freeways are operating over time, as well as where potential improvement projects may be necessary. This report is typically used as a starting point for more detailed analysis incorporating additional probe data, as well as other MDOT resources. If your area has plans to share this information externally, please contact the Congestion and Reliability Unit to ensure the correct measures are being used.

The report was prepared by the Wayne State University Transportation Research Group under the guidance of the Congestion and Reliability Unit at MDOT. Please contact the Congestion and Reliability Unit if you have any questions/comments or would like to have the actual data for further analysis.

ACKNOWLEDGEMENTS

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INTRODUCTION

The purpose of this document is to provide a performance overview of Michigan freeways. Using probe vehicle data and systematic performance measures, a series of visualizations were created for each region in the state. Chapter 8 of this report provides an overview of the University Region. University Region is made up of 9 counties and contains the cities of Lansing, Jackson, and Ann Arbor. Nine freeways are analyzed in the section below.

PERFORMANCE MEASURES DEFINITIONS

The probe data alone provides representative speeds on predefined segments of roadway every minute. Although this data is rich, it provides limited use to engineers and practitioners without well-defined aggregation techniques. Performance measures are growing in the transportation arena to better monitor traffic conditions, improve traveler information, and identify congested areas with the aim of improving operations on roadways. A summary of the performance measures used in this report can be seen in Table 1.

The goal of these performance measures is to quantify the congestion, delay, and reliability of the freeway network in Michigan. Numerous metrics were used in this report to quantify the performance of the road network, including a new delay index. Delay is quantified when the speed drops below 60 MPH, which is at least 10 MPH lower than the posted speed limit for the freeways (Figure 1). On segments with a speed limit of 55 MPH, delay is calculated when speed falls below that threshold. The delay index presented in this report represents the total delay on each segment if one vehicle were to drive that segment every ten minutes. The lower the value, the better the freeway segment is operating. The other element of interest is reliability. Reliability is a measure of the consistency of a travel time on a roadway. A roadway that has the same travel time every day is said to be reliable, whereas a roadway that has varying travel times is said to be unreliable. MDOT's goal is to provide reliable travel times with minimal delay. This is done through roadway improvement projects which can include additional lanes, pavement improvements, and intelligent transportation systems. These projects can reduce the travel time and also improve the travel time reliability. An example of this is shown in Figure 2.

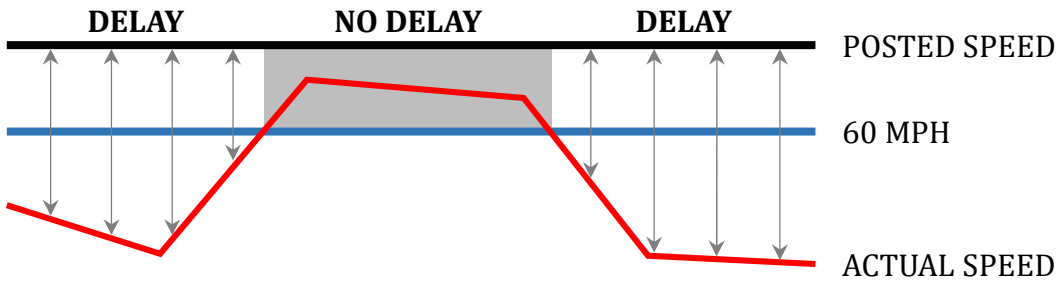


FIGURE 1. Delay Calculation

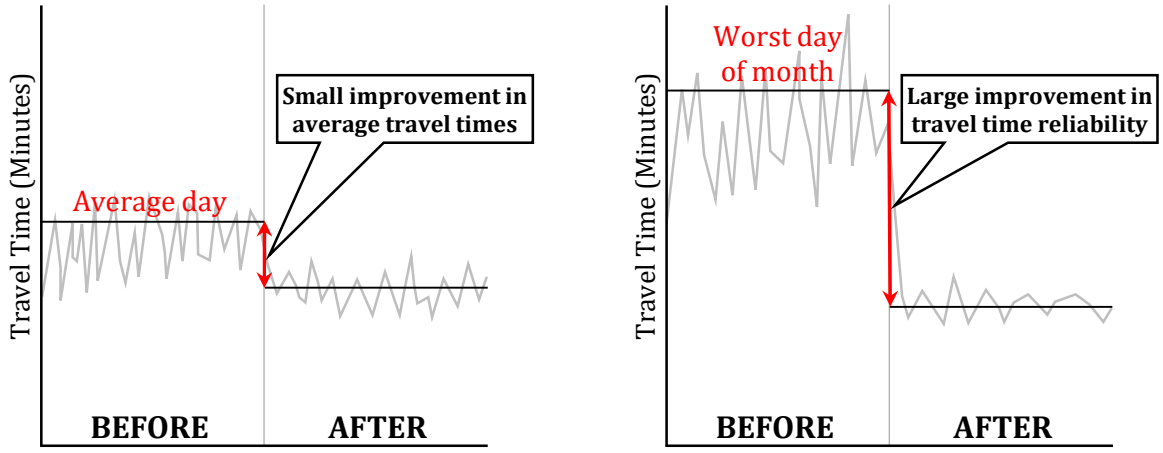


FIGURE 2. Travel Time Average and Reliability Improvements

TABLE 1. Performance Measures of Interest

PERFORMANCE MEASURE	Description
DELAY	Delay is calculated by taking the difference between actual speeds when they fall below 60 MPH and the posted speed limit. This is to take out the delay caused by the lower average speeds from commercial vehicles.
DELAY INDEX	Delay index is calculated by adding the delay if a probe vehicle drove every segment of roadway once every ten minutes. This value is then divided by the length of the roadway segment. This allows users to make comparisons between varying corridors and locate areas that cause the most delay.
MAXIMUM DELAY	Maximum delay is the maximum calculated delay per segment throughout a year.
AVERAGE SPEED	Average speed is determined by calculating the space mean speed of the worst ranked hour in the weekday AM peak (6:00 AM - 9:00 AM) and weekday PM peak (3:00 PM - 7:00 PM) periods for each segment of roadway. This is compared to the space mean speed of the previous five year period for the same hour.
CONGESTION SEVERITY	Congestion severity is calculated based on the worst hourly average speed experienced during the AM or PM peak period per traffic message channel (TMC) segment. A TMC segment is a standard for delivering real-time traffic information. They vary from tenths of a mile long to several miles long.
TRAVEL TIME RELIABILITY	Travel time reliability is a measure of travel time consistency over a period of time. When travel times are unreliable, customers are more likely to experience unexpected delays. Travel times are shown to be reliable when the 95th percentile travel time remains close to the average travel time.
AVERAGE TRAVEL TIME	The amount of time a customer should budget to be on-time on average.
95TH PERCENTILE TRAVEL TIME	The amount of time a customer should budget to be on-time 19 out of 20 days (95% of the time). The 95th percentile travel time is also known as the planning time.
LEVEL OF TRAVEL TIME RELIABILITY	Level of travel time reliability (LOTTR) is calculated as the ratio of the 80th percentile travel time to a "normal" travel time (50th percentile). LOTTR measures the consistency and dependability of road segments. The Federal Highway Administration (FHWA) deemed a road segment to be unreliable if its LOTTR value exceeds 1.50.

Note: May 1st through September 30th were used for the summer reliability calculations.

PERFORMANCE MEASURES VISUALIZATIONS

Performance measures visualizations provide an easy way to graphically represent the performance metrics listed above. In this report, five main visualizations are used. These five visualizations are explained in detail below.

DELAY INDEX

Figure 3 is an example of the delay index graph. This figure represents I-94 through Washtenaw County in the University Region. The delay index visualization displays which months are incurring the most delay, while comparing how delay patterns change from year-to-year. Figure 3 shows the following:

a) Yearly delay index per mile totals (in minutes).
b) Delay index per mile (in minutes).
c) Month of year.
d) Higher than normal delay index per mile value in January 2014.
e) A delay index per mile value of 150 minutes in March 2016.

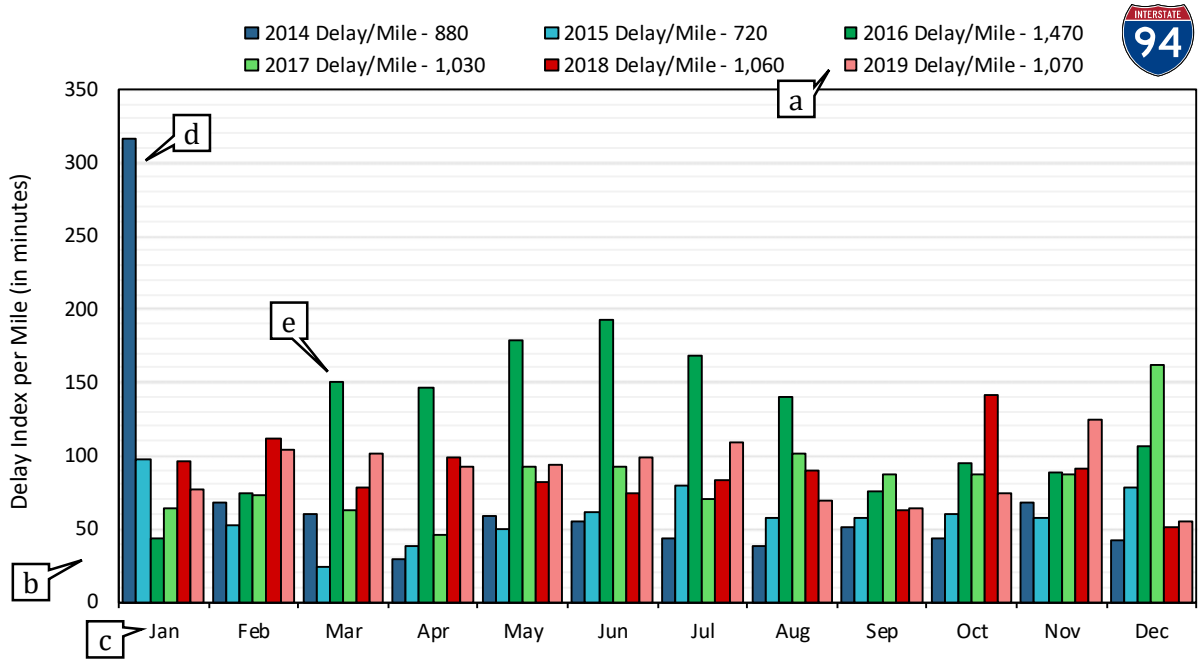


FIGURE 3. Example Delay Index Graph

AVERAGE SPEED

Figure 4 is an example of the average speed graph. This figure represents westbound I-94 through the University Region. This performance metric visualizes the speeds on a given corridor during the AM and PM peak periods, along with a 5-year historical average of those speeds. Average speed graphs can display how morning and evening peak speeds can vary by time and magnitude. The following criteria was used in the making of these graphs:

- Only weekdays (Monday – Friday) are included in the calculations.
- The AM peak hour is the worst ranked hour between 6:00 AM – 9:00 AM.
- The PM peak hour is the worst ranked hour between 3:00 PM – 7:00 PM.
- The worst ranked hour is based on the lowest average speed and minimum speed experienced during the peak hours.

Figure 4 shows the following:

a) Legend.
b) Location of interchanges by exit/mile marker number.
c) Specific significant interchanges.
d) Direction of travel.
e) Average speed in MPH.
f) Example of low speed area during the AM peak while near US-12 interchange.
g) Example of location where PM peak speeds are lower than AM peak speeds.
h) Example of limited change in speed from year to year.
i) 2019 PM peak average speed is approximately 50 MPH at Exit 142.

AVERAGE SPEED

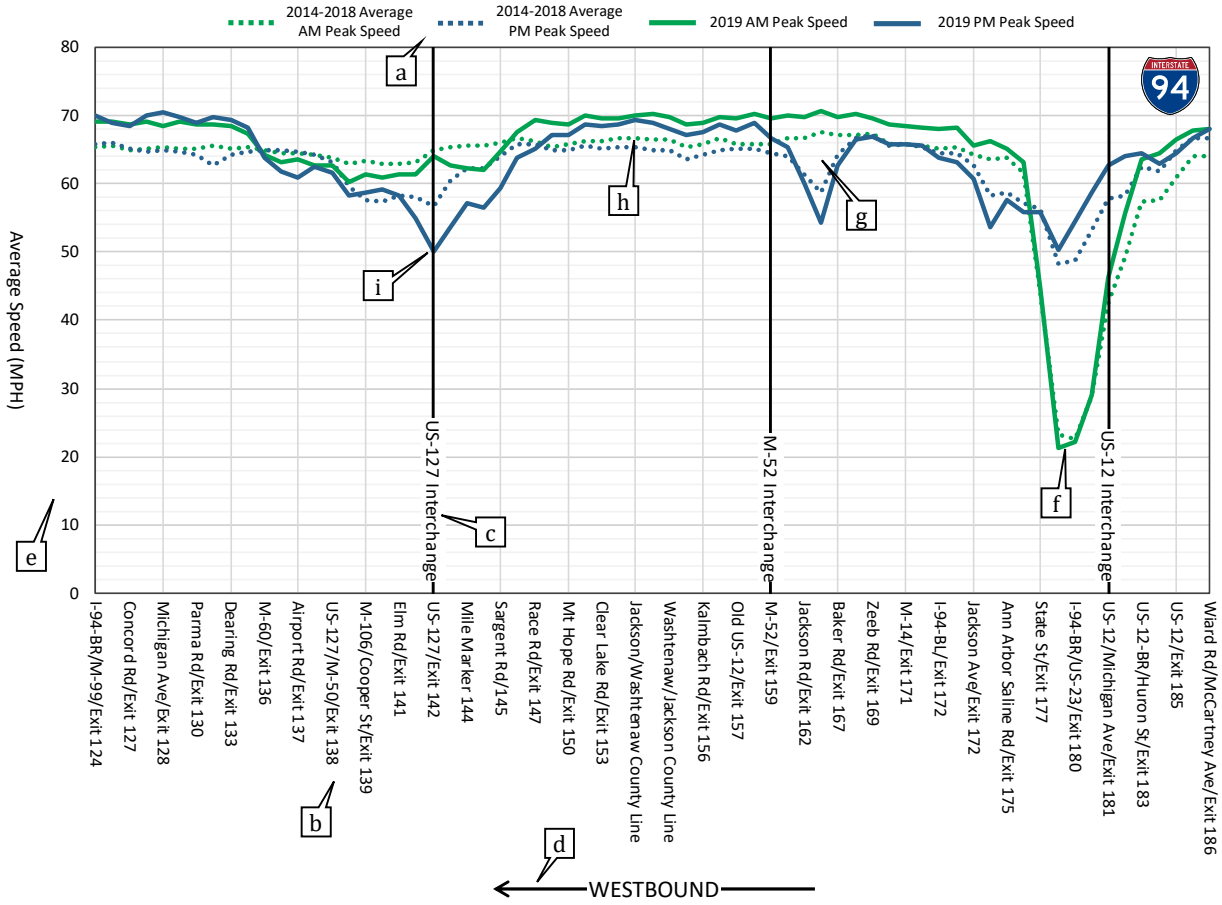


FIGURE 4. Example Average Speed Graph

CONGESTION SEVERITY

Figure 5 shows an example of the congestion severity map. This figure represents University Region during the AM peak hour. This performance metric displays the amount of congestion on corridors during AM and PM peak periods by representing speeds in a color gradient. The color gradient consists of three different categories to distinguish severity levels:

- Low (≥55 MPH).
- Moderate (≥35 MPH & <55 MPH).
- Severe (<35 MPH).

Figure 5 shows the following:

a) Location of no congestion in either direction during the AM peak hour.
b) Congestion exists only in the westbound direction of travel on M-14 from people commuting to work from home during morning hours.

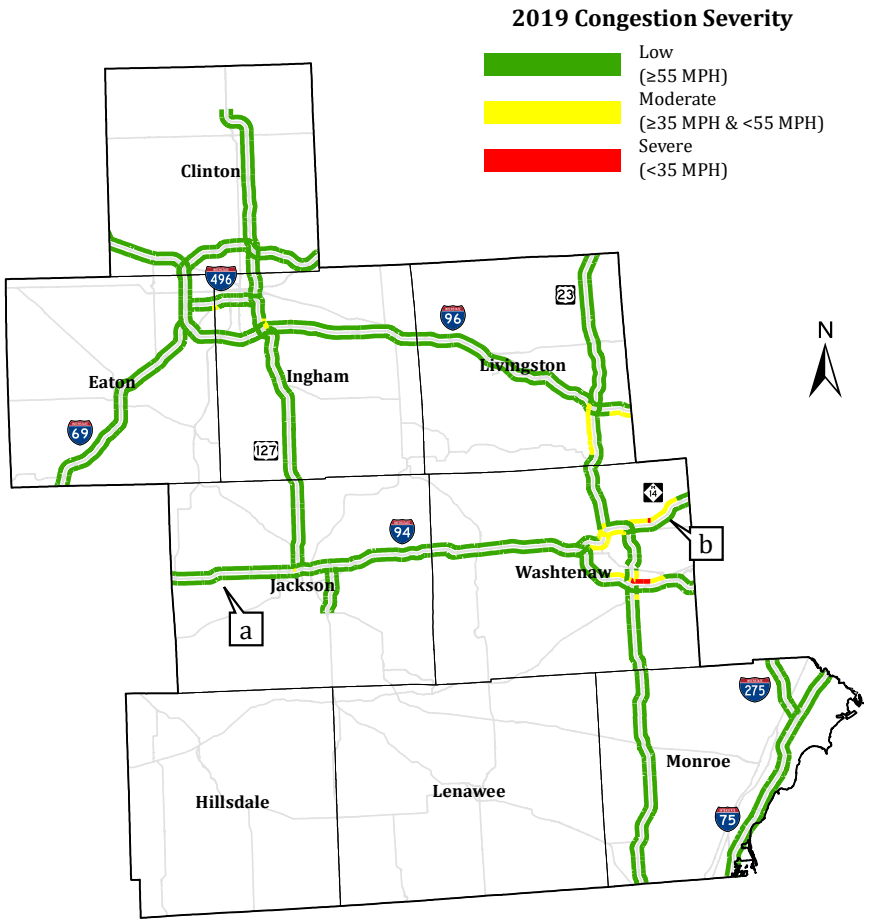


FIGURE 5. Example Congestion Severity Map

TRAVEL TIME RELIABILITY

Figure 6 is an example of the travel time reliability graph. This figure represents a portion of eastbound I-94 through the University Region. This performance metric displays the reliability of a given corridor over time. A segment is deemed "reliable" when the average and 95th percentile travel times are constant. A segment is deemed "unreliable" when the average and 95th percentile travel times differ by a large amount of time. Figure 6 shows the following:

a) The 95th percentile travel time reliability and the average (50th percentile) travel time reliability.
b) Amount of time it will take a vehicle to drive the entire corridor in minutes.
c) Time of day.
d) Small difference between average and 95th percentile travel times (reliable).
e) Large difference between average and 95th percentile travel times (unreliable).

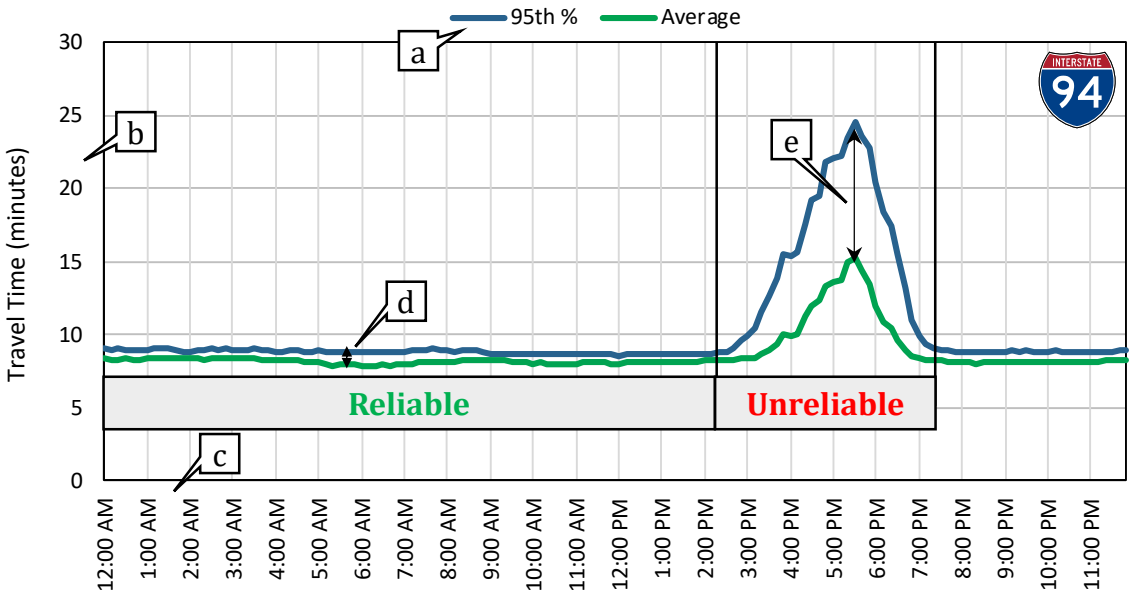


FIGURE 6. Example Travel Time Reliability Graph

LEVEL OF TRAVEL TIME RELIABILITY

Figure 7 shows an example of the level of travel time reliability (LOTTR) figure. This figure represents westbound I-94 through the University Region. This performance metric displays the consistency and dependability of road segments by analyzing vehicular travel times from day-to-day or across different times of the day. LOTTR is defined as the ratio between the 80th-percentile travel time to the 50th-percentile travel time. In order to determine if a road segment has reliable travel times, LOTTR utilizes a threshold value of 1.50. Therefore, a segment providing a calculated LOTTR value less than 1.50 would claim to have reliable travel times. As delegated by FHWA, the following time periods were used in the making of these graphs:

- Weekdays between 6:00 AM – 10:00 AM.
- Weekdays between 10:00 AM – 4:00 PM.
- Weekdays between 4:00 PM – 8:00 PM.
- Weekends between 6:00 AM – 8:00 PM.

Figure 7 shows the following:

a) Legend.
b) Location of interchanges by exit/mile marker number.
c) Specific significant interchanges.
d) Direction of travel.
e) Level of travel time reliability.
f) Threshold value of 1.50.
g) This section of roadway has reliable travel times because the LOTTR values of the four time periods are below 1.50.
h) Area of unreliable travel times during weekdays between 6:00 AM – 10:00 AM (AM peak).

LEVEL OF TRAVEL TIME RELIABILITY

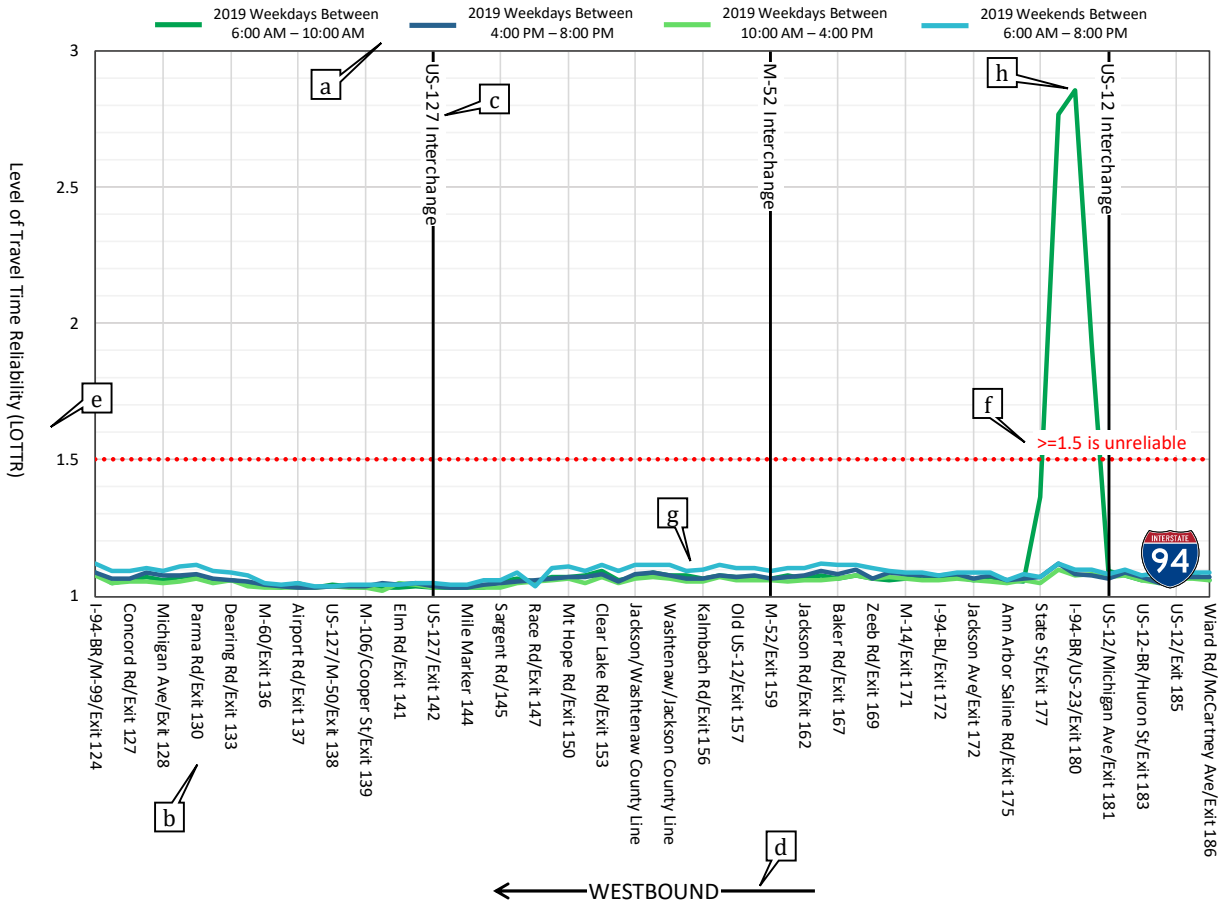


FIGURE 7. Example Level of Travel Time Reliability Figure

Figure 8 shows an example of the level of travel time reliability map. This figure represents University Region during weekdays between 4:00 PM – 8:00 PM. This performance metric displays the level of travel time reliability on corridors during each of the four time periods mentioned above. LOTTR is represented in a color gradient that consists of three different categories to distinguish severity levels:

- Low (<1.25 LOTTR).
- Moderate (≥1.25 LOTTR & <1.50 LOTTR).
- Severe (≥1.50 LOTTR).

Figure 8 shows the following:

a) Most roads have very reliable travel times because the LOTTR values are below 1.25.
b) Unreliable travel times occur southbound US-23 near Ann Arbor.
c) Unreliable travel times occur near the I-96 and US-23 interchange.

LEVEL OF TRAVEL TIME RELIABILITY

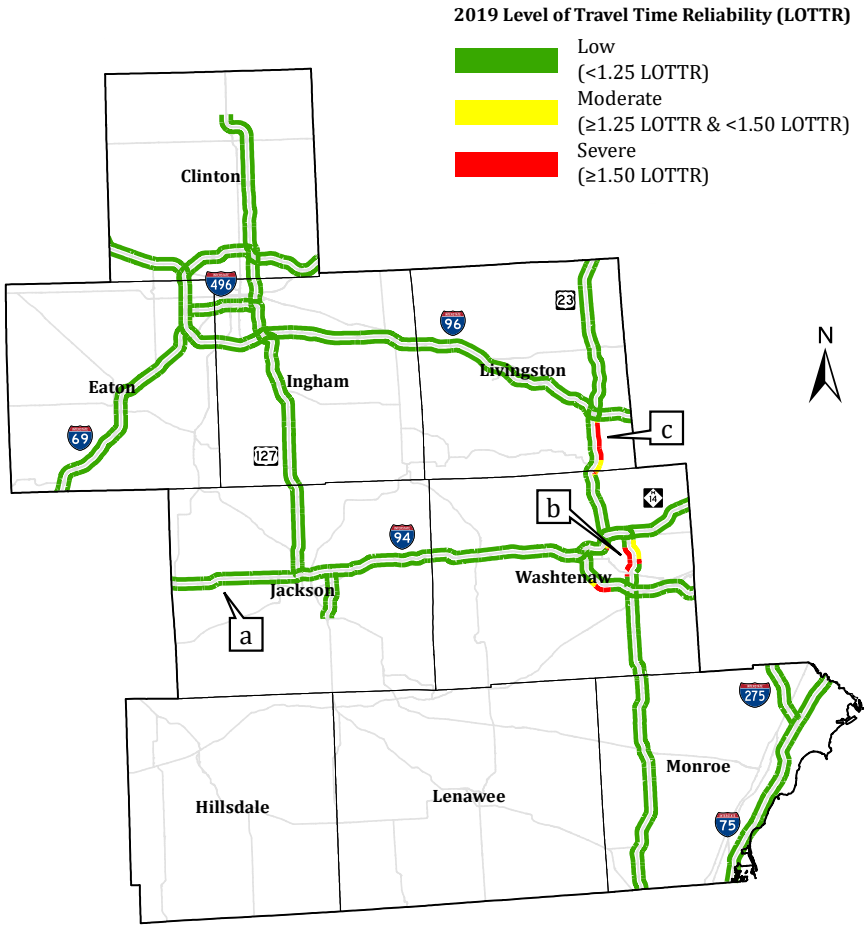


FIGURE 8. Example Level of Travel Time Reliability Map

UNVIERSITY REGION: OVERVIEW

UNIVERSITY REGION: DELAY INDEX

The following table ranks the University Region freeways based on the delay index. Each freeway segment is presented on a countywide or TSC basis, as appropriate.

TABLE 2. 2019 University Region Delay Index Data

Rank	Location (Route, County)	2019 Delay Index per Mile (in minutes)
1	M-14 – Washtenaw County	1,488
2	US-23 – Washtenaw County	1,226
3	US-23 – Livingston County	1,078
4	I-94 – Washtenaw County	1,062
5	I-75 – Monroe County	787
6	I-496 – Eaton and Ingham County	768
6	I-94 – Jackson County	644
8	I-96 – Ingham County	547
9	I-96 – Livingston County	493
10	I-96 – Clinton and Eaton County	475
11	US-127 – Ingham County	468
12	US-127 – Jackson County	390
13	US-23 – Monroe County	333
14	I-69 – Clinton County	321
15	I-69 – Eaton County	306
16	US-127 – Clinton County	242
17	I-275 – Monroe County	230

UNVIERSITY REGION: CONGESTION SEVERITY

The following tables display the amount of congestion miles per region that fall into each severity level. Table 3 shows this data during the AM peak and Table 4 shows this data during the PM peak. These tables can be utilized to compare the amount and severity of congestion across all regions. Figures 9-10 represent this information specifically in the University Region. Figure 9 shows the congestion severity during the AM peak and Figure 10 shows the congestion severity during the PM peak.

TABLE 3. 2019 Congestion Miles by Severity - AM Peak

Region	Low	Moderate	Severe
Bay	751.5	0.7	0.0
Grand	667.1	31.6	5.5
Metro	420.5	146.1	27.0
North	376.8	0.2	0.0
Southwest	473.2	1.4	0.0
Superior	98.2	2.7	0.6
University	710.2	31.4	3.5
Total	**3,497.5**	**214.1**	**36.6**

TABLE 4. 2019 Congestion Miles by Severity - PM Peak

Region	Low	Moderate	Severe
Bay	745.6	6.7	0.0
Grand	642.4	51.6	10.2
Metro	371.9	173.0	48.7
North	377.0	0.0	0.0
Southwest	473.3	1.3	0.0
Superior	99.8	1.0	0.6
University	698.9	36.1	10.1
Total	**3,408.9**	**269.7**	**69.6**

UNIVERSITY REGION: CONGESTION SEVERITY

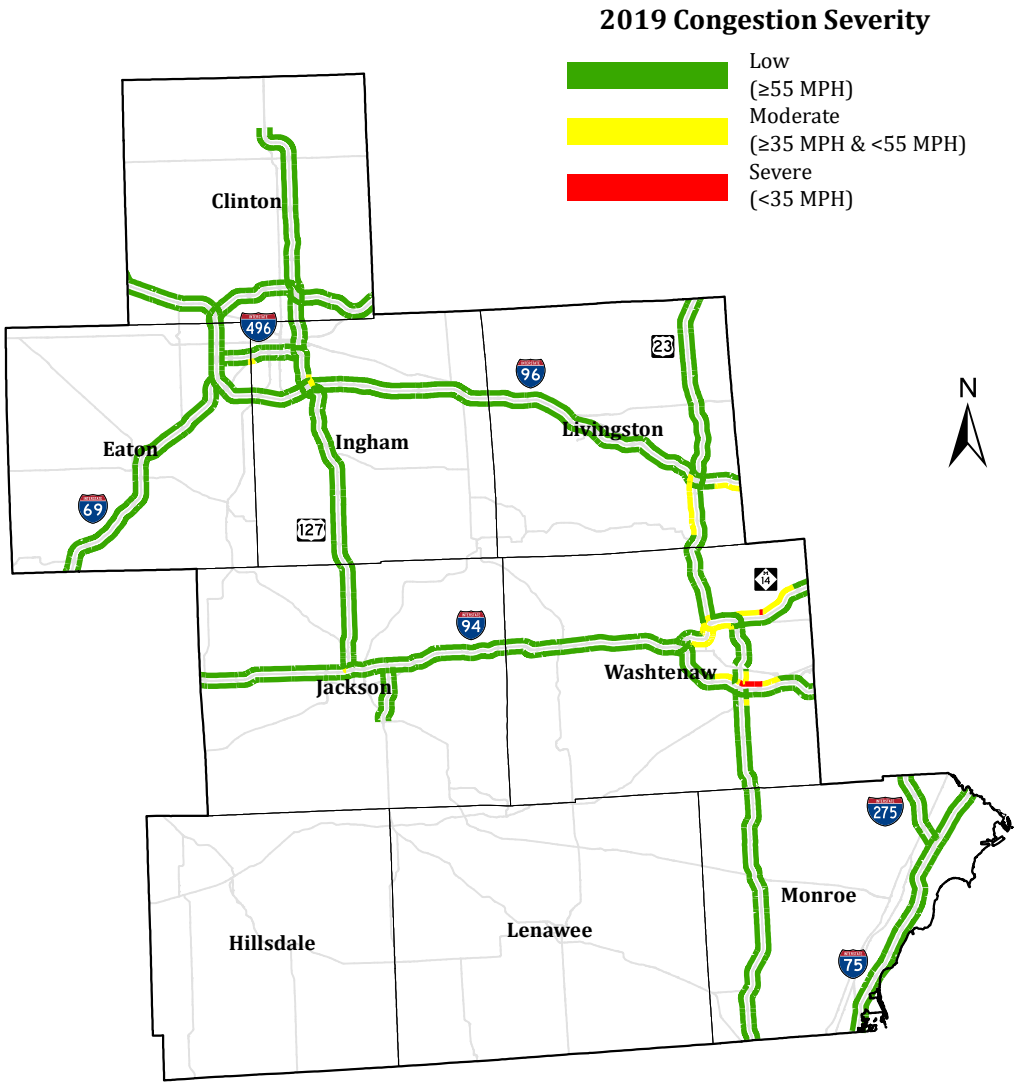


FIGURE 9. 2019 University Region AM Peak Congestion Severity

UNIVERSITY REGION: CONGESTION SEVERITY

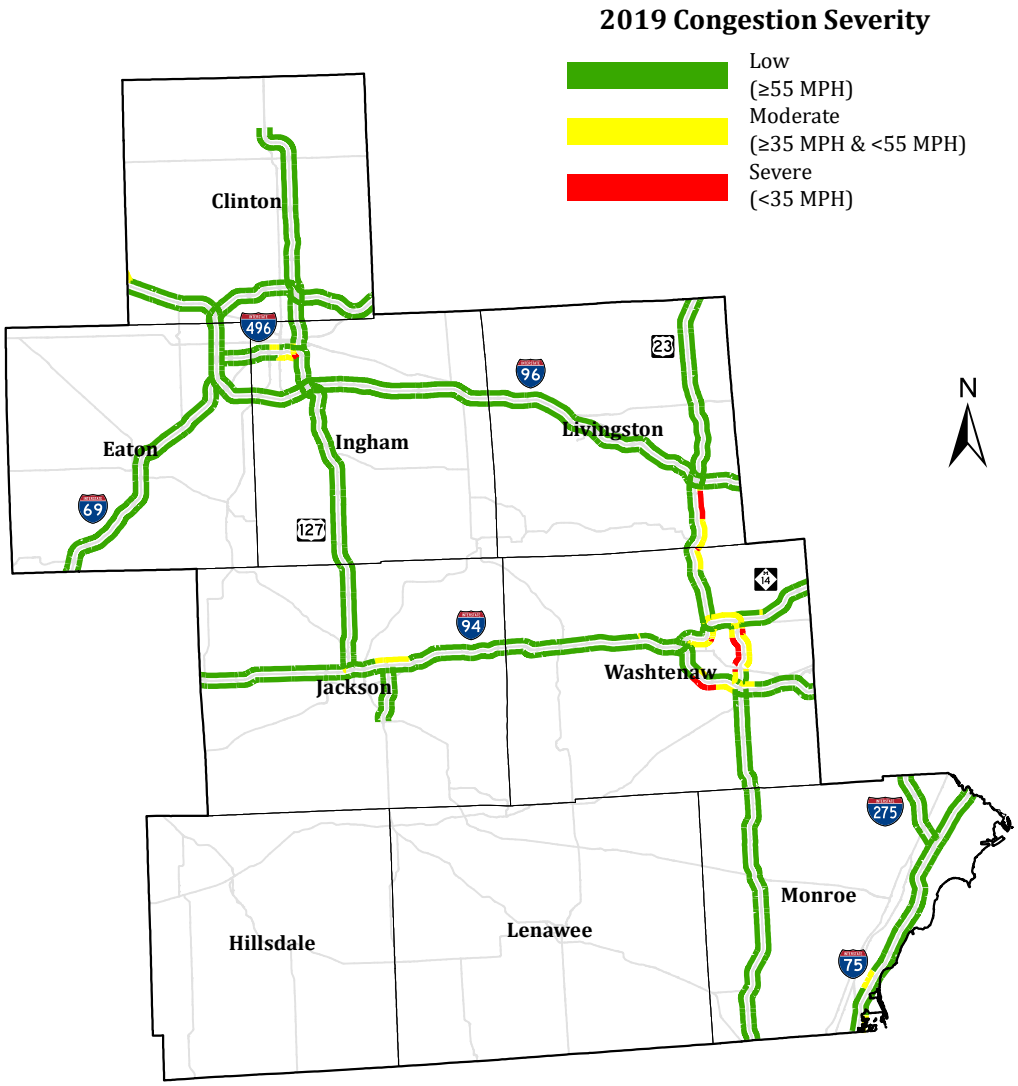


FIGURE 10. 2019 University Region PM Peak Congestion Severity

UNIVERSITY REGION: LEVEL OF TRAVEL TIME RELIABILITY

The following figures display the level of travel time reliability (LOTTR) based on severity level in the University Region. Figures 11-13 display the LOTTR during weekdays between 6:00 – 10:00 AM, 10:00 AM – 4:00 PM, and 4:00 PM – 8:00 PM, respectively. Figure 14 displays the LOTTR during weekends between 6:00 AM – 8:00 PM.

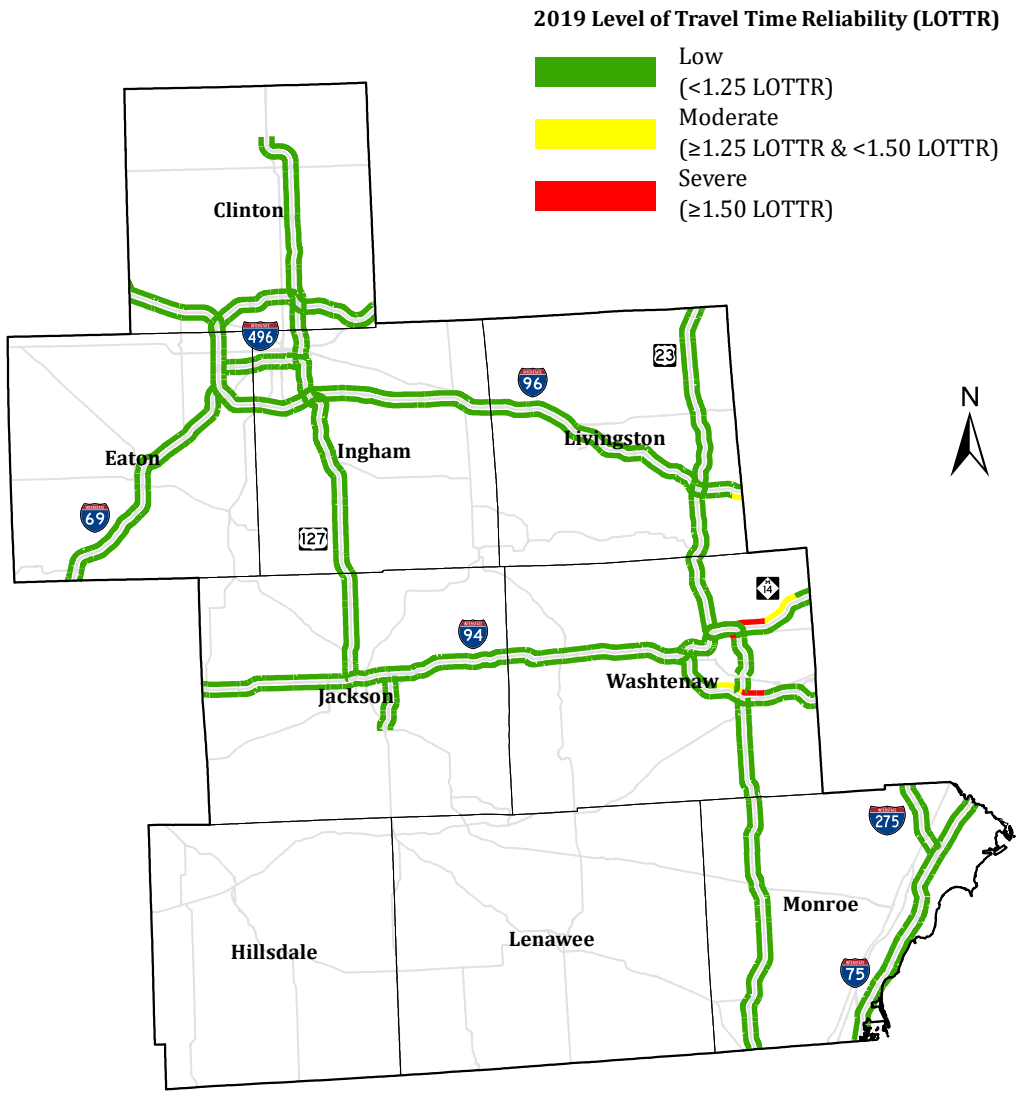


FIGURE 11. 2019 University Region Level of Travel Time Reliability (Weekdays between 6:00 AM – 10:00 AM)

UNIVERSITY REGION: LEVEL OF TRAVEL TIME RELIABILITY

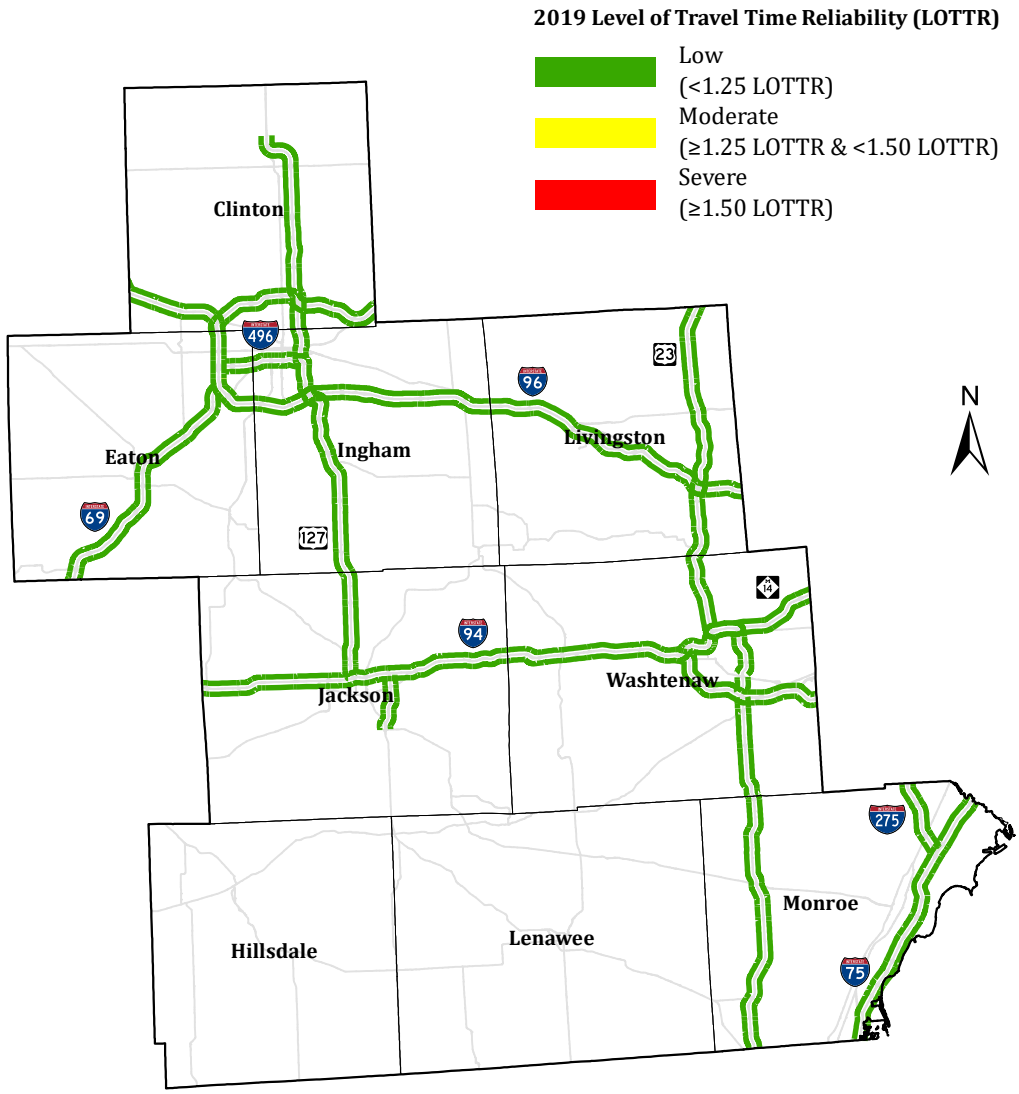


FIGURE 12. 2019 University Region Level of Travel Time Reliability (Weekdays between 10:00 AM – 4:00 PM)

UNIVERSITY REGION: LEVEL OF TRAVEL TIME RELIABILITY

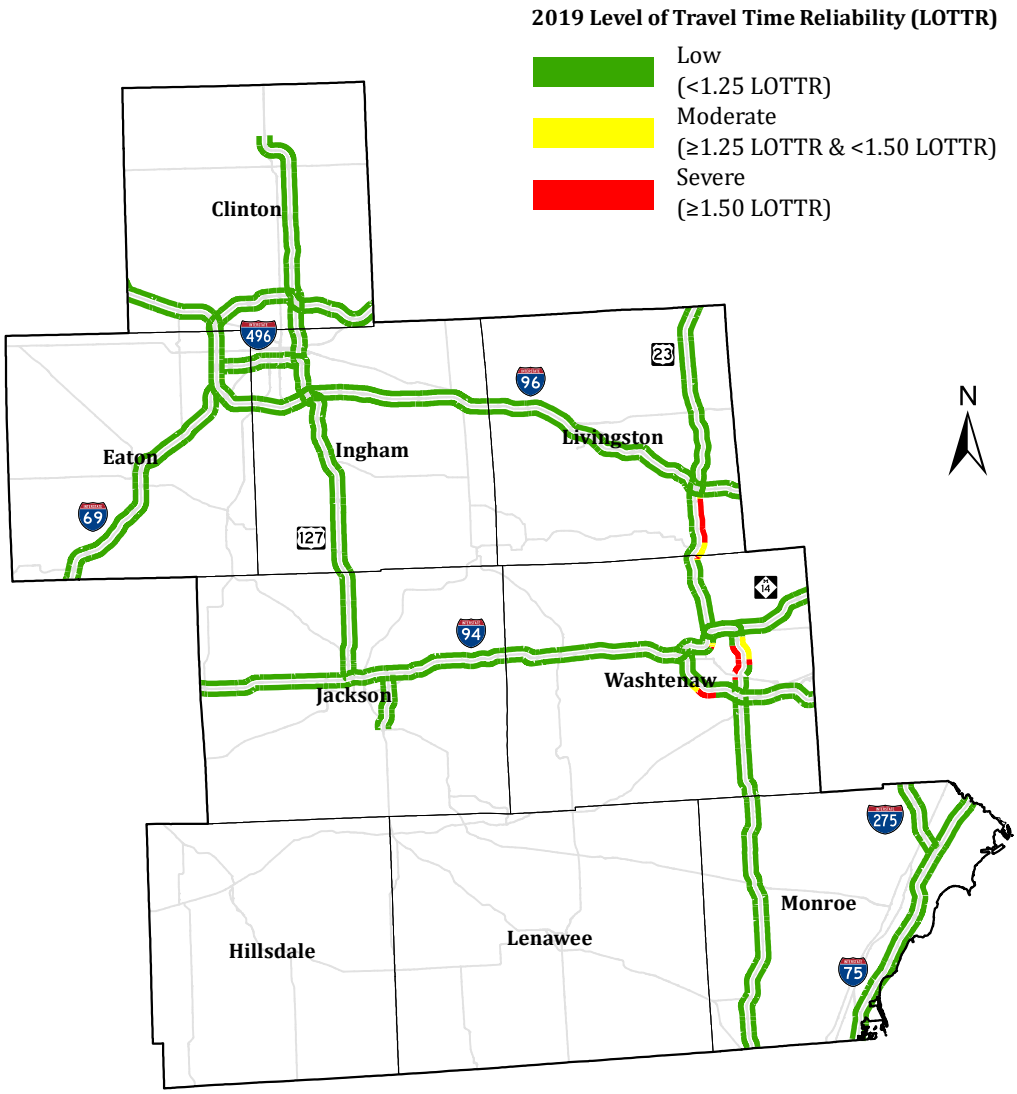


FIGURE 13. 2019 University Region Level of Travel Time Reliability (Weekdays between 4:00 PM – 8:00 PM)

UNIVERSITY REGION: LEVEL OF TRAVEL TIME RELIABILITY

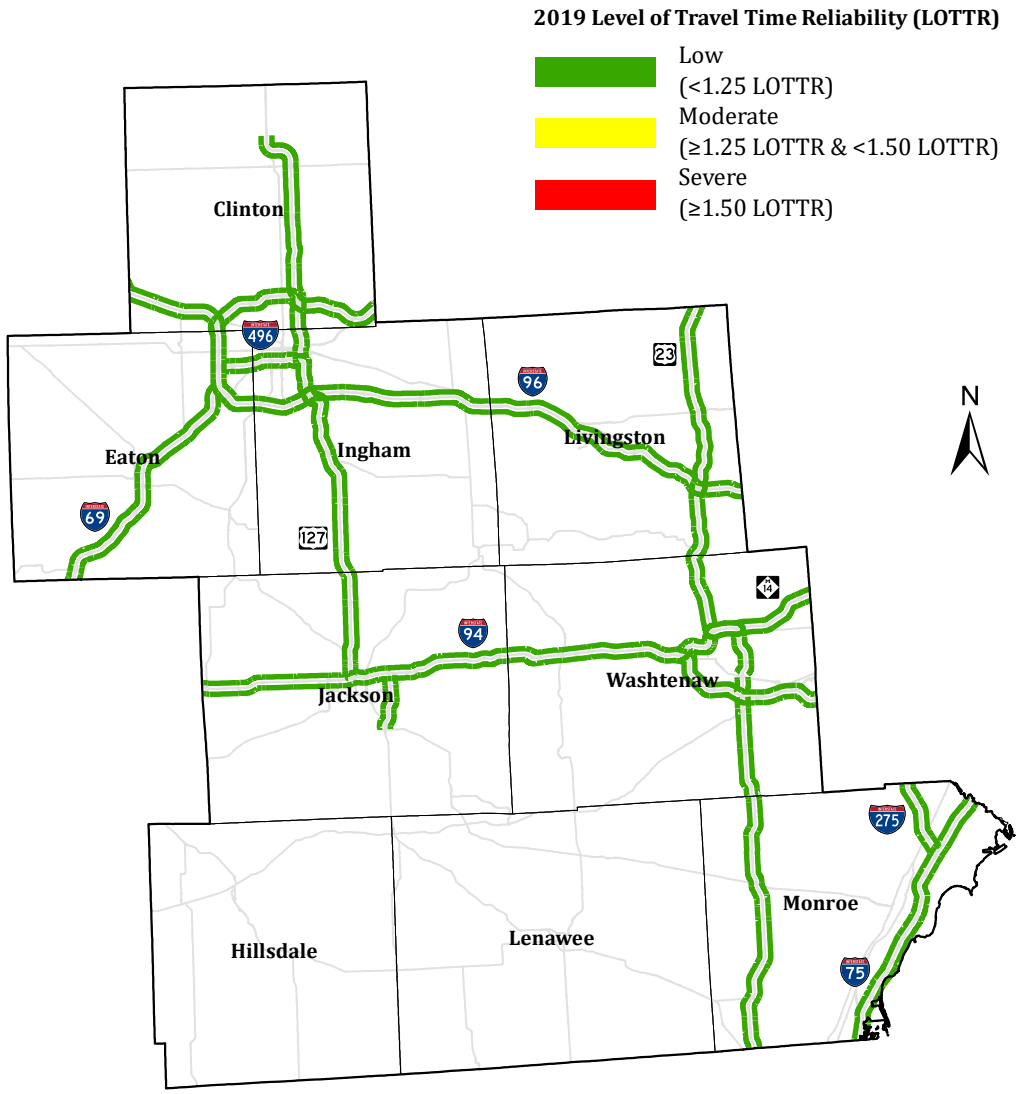
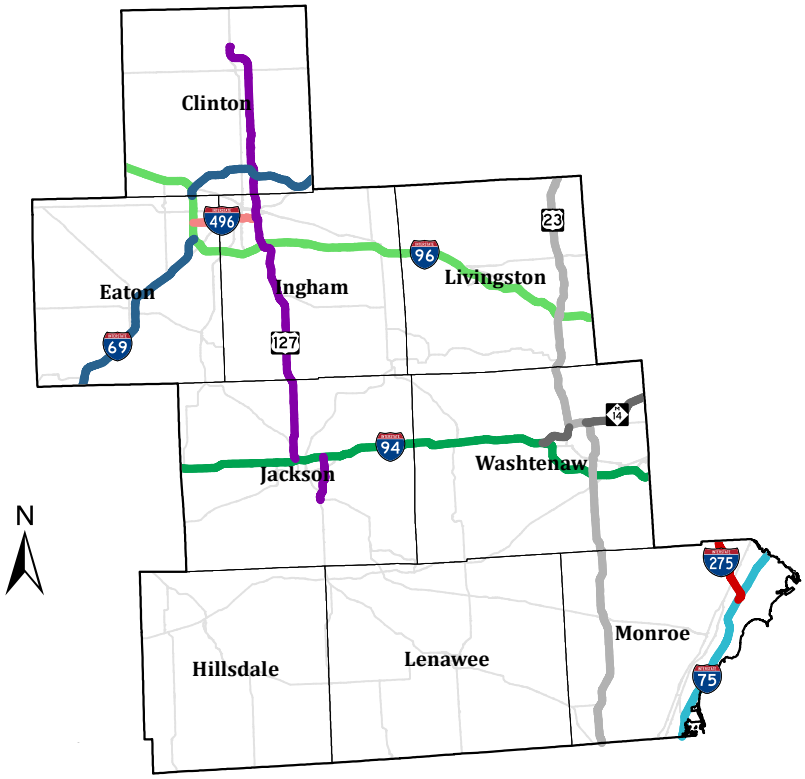
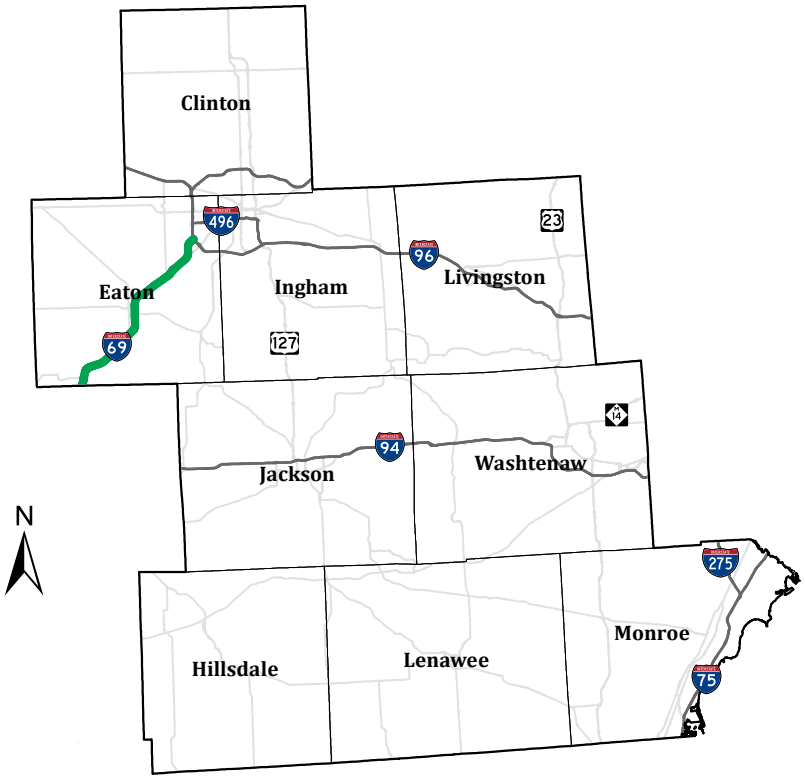


FIGURE 14. 2019 University Region Level of Travel Time Reliability (Weekends between 6:00 AM – 8:00 PM)

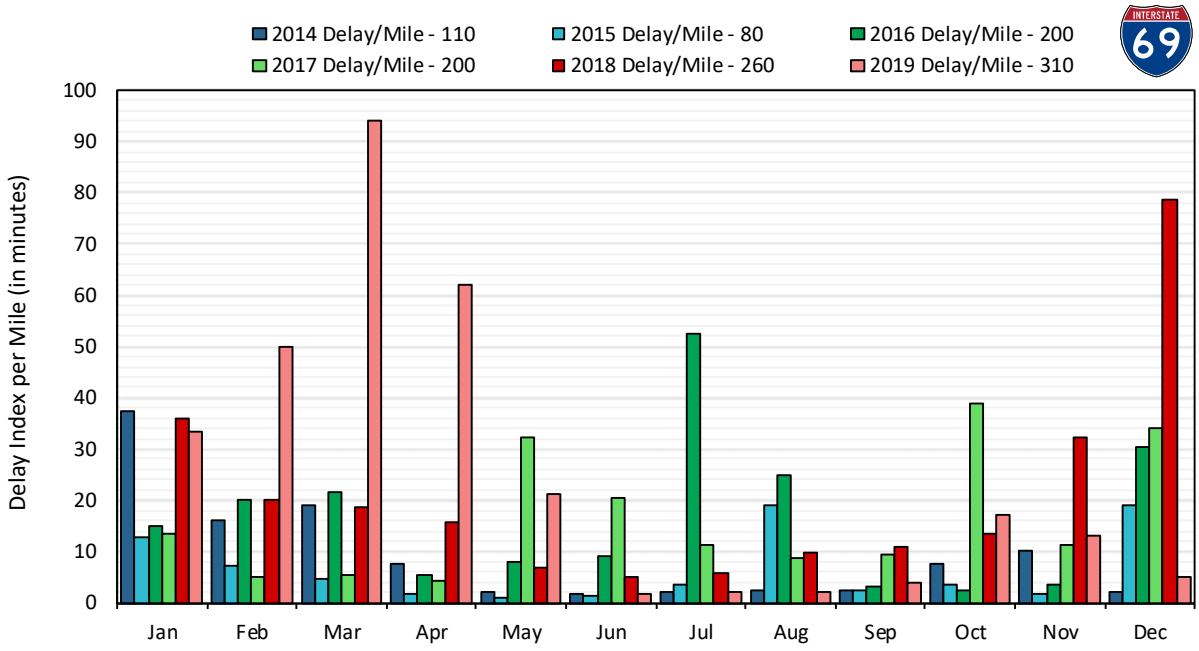
UNIVERSITY REGION: CORRIDOR GLOSSARY



I-69: EATON COUNTY DELAY INDEX



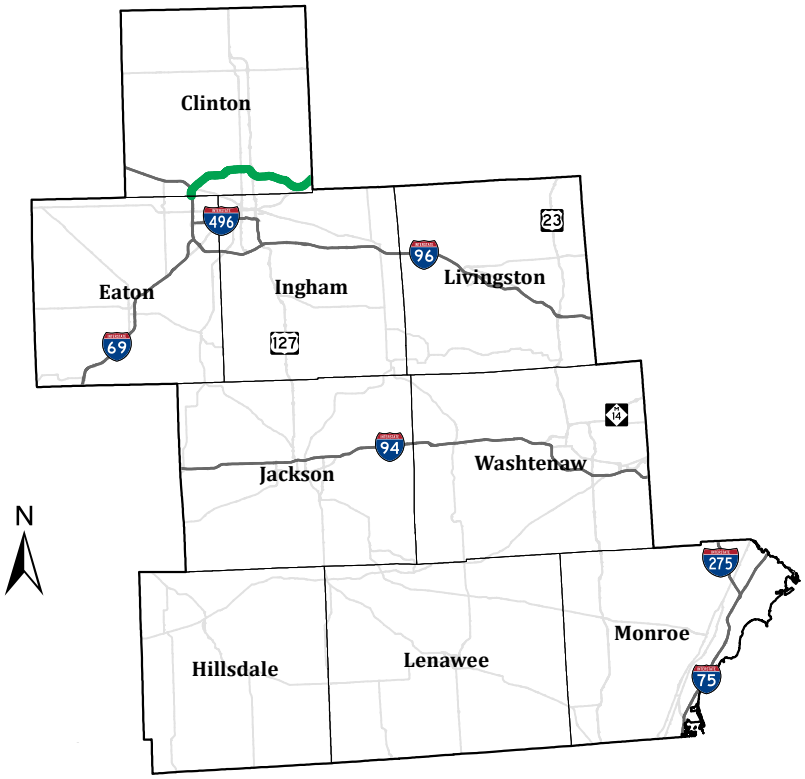
a) Segment Map



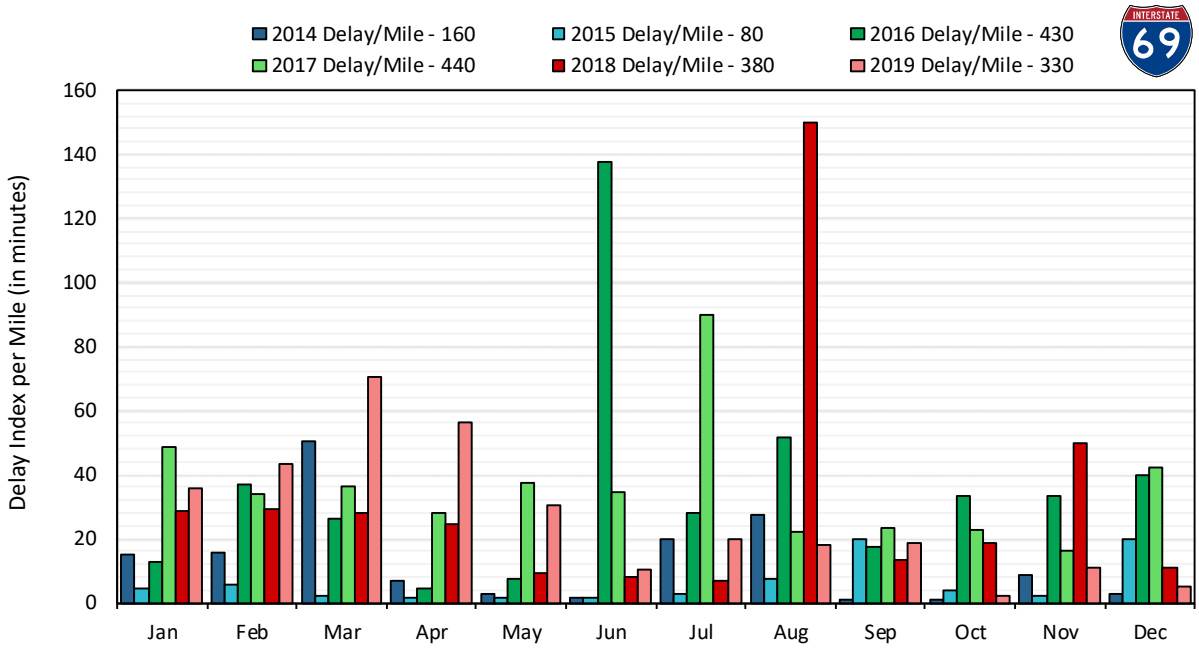
b) Delay Index Graph

FIGURE 15. Eaton County I-69 Corridor Delay Index

I-69: CLINTON COUNTY DELAY INDEX



a) Segment Map



b) Delay Index Graph

FIGURE 16. Clinton County I-69 Corridor Delay Index

I-69: AVERAGE SPEED

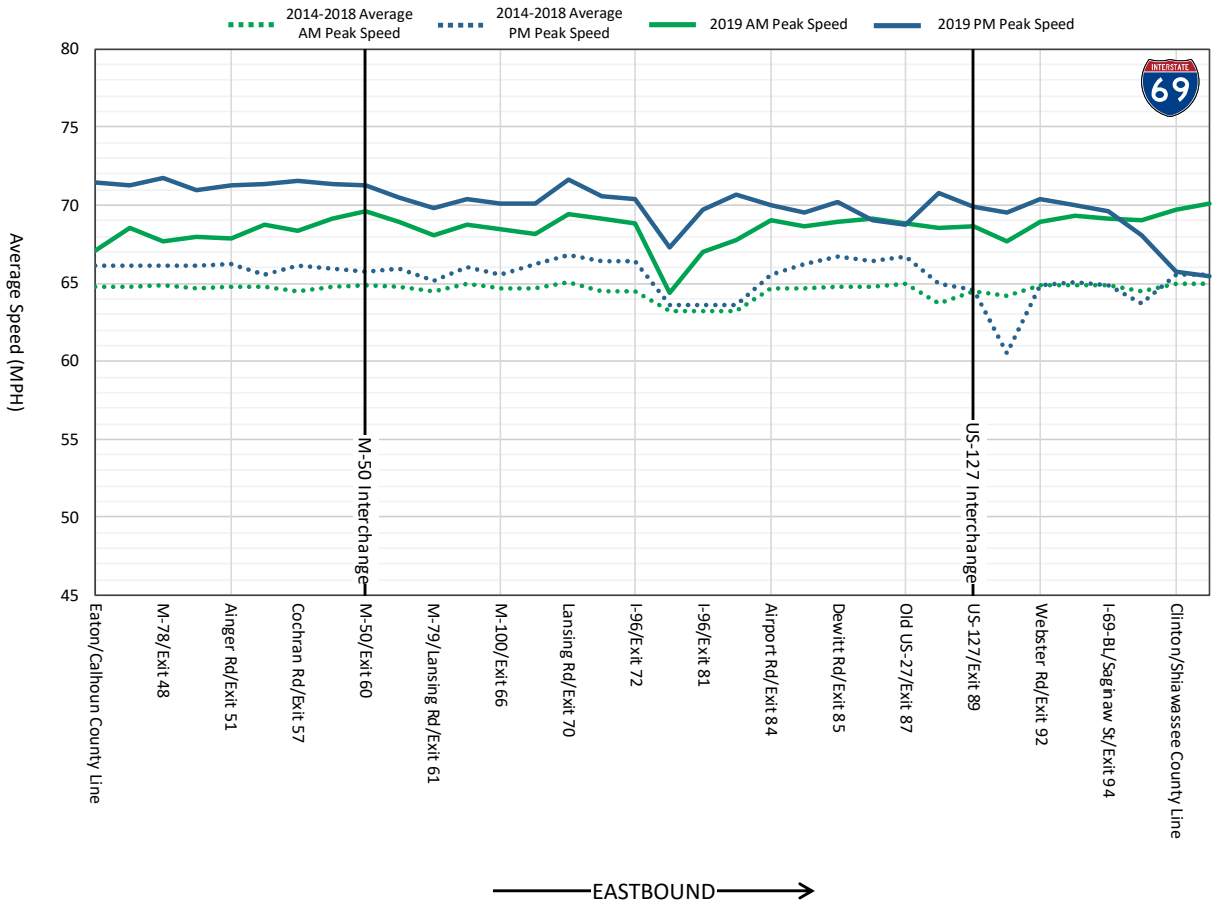


FIGURE 17. University Region Eastbound I-69 Average Speed

I-69: AVERAGE SPEED

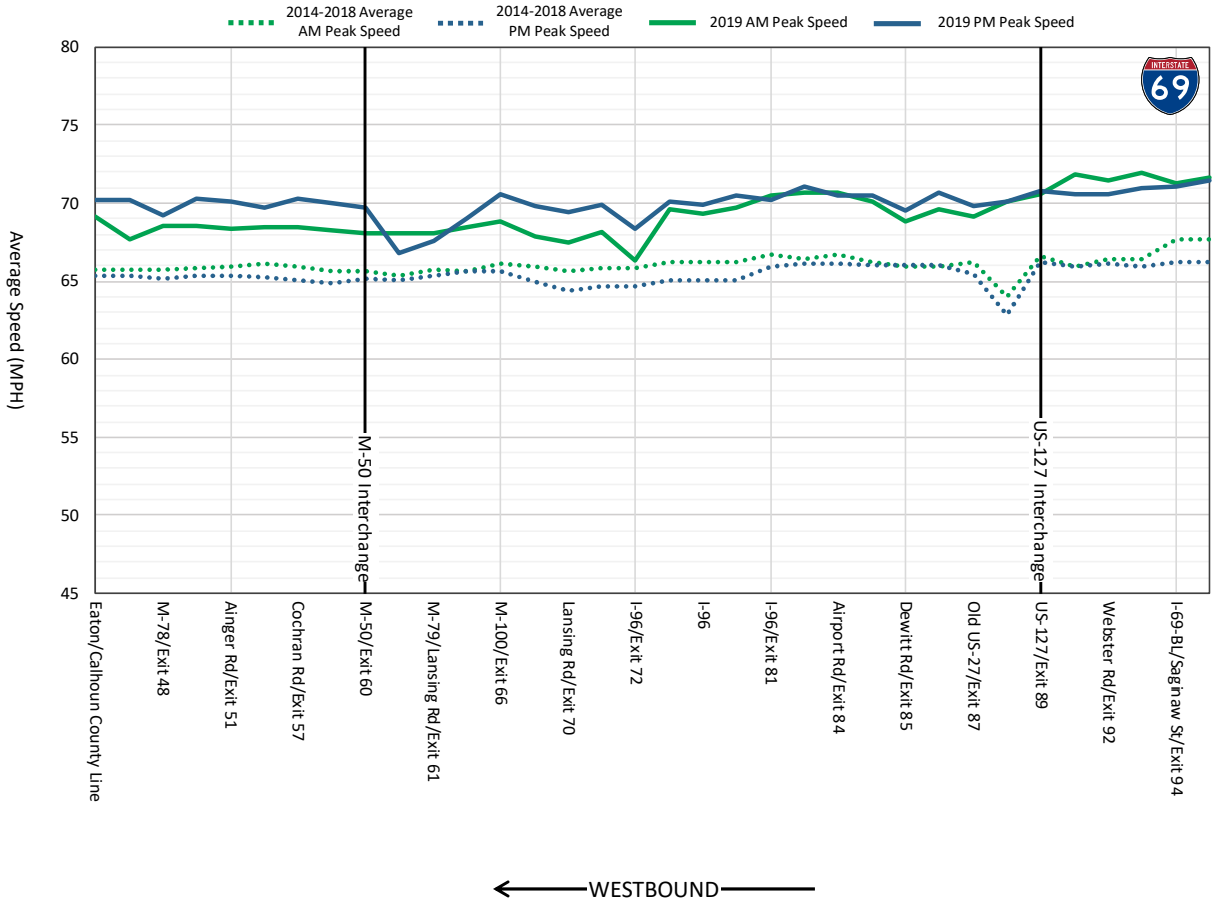


FIGURE 18. University Region Westbound I-69 Average Speed

I-69: LEVEL OF TRAVEL TIME RELIABILITY

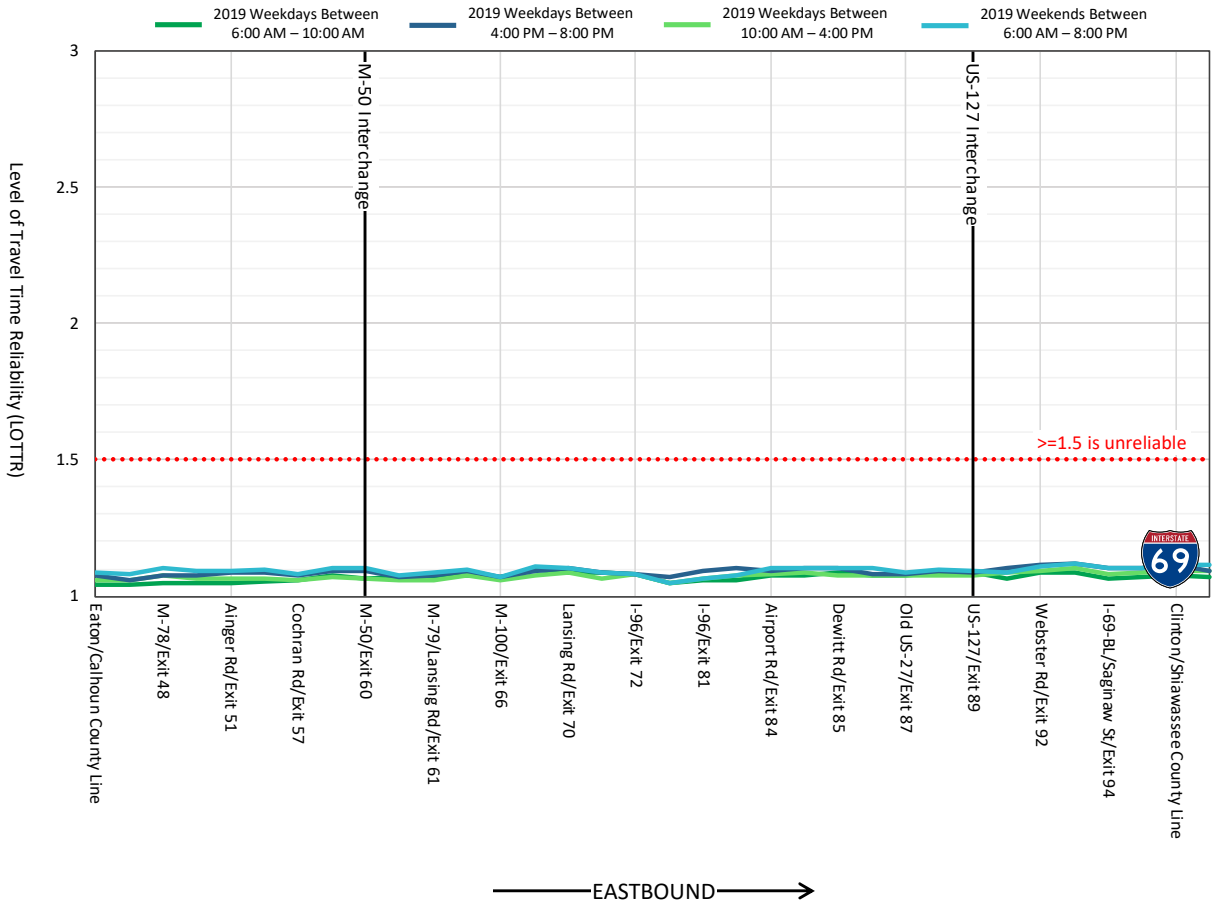


FIGURE 19. University Region Eastbound I-69 Level of Travel Time Reliability

I-69: LEVEL OF TRAVEL TIME RELIABILITY

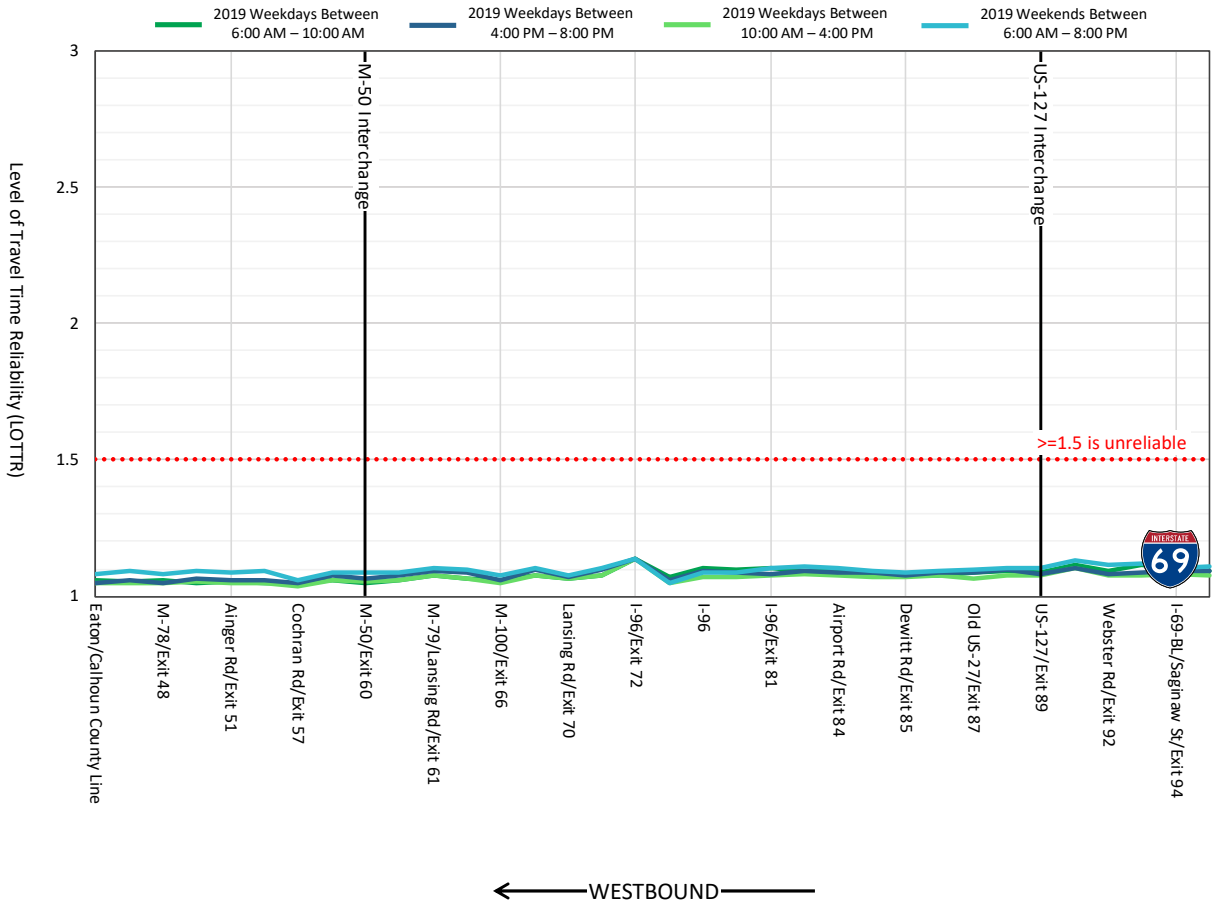
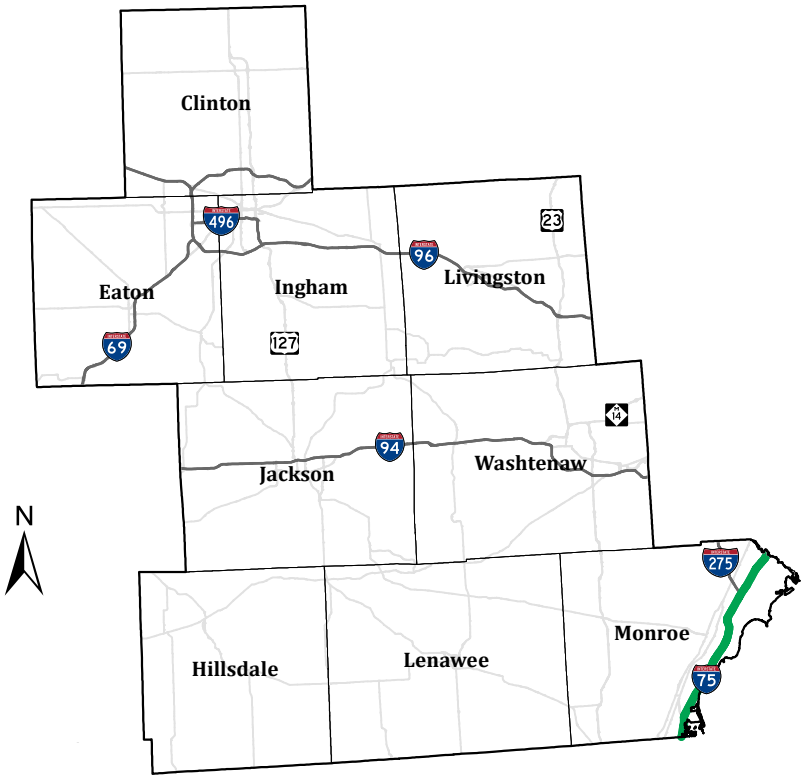
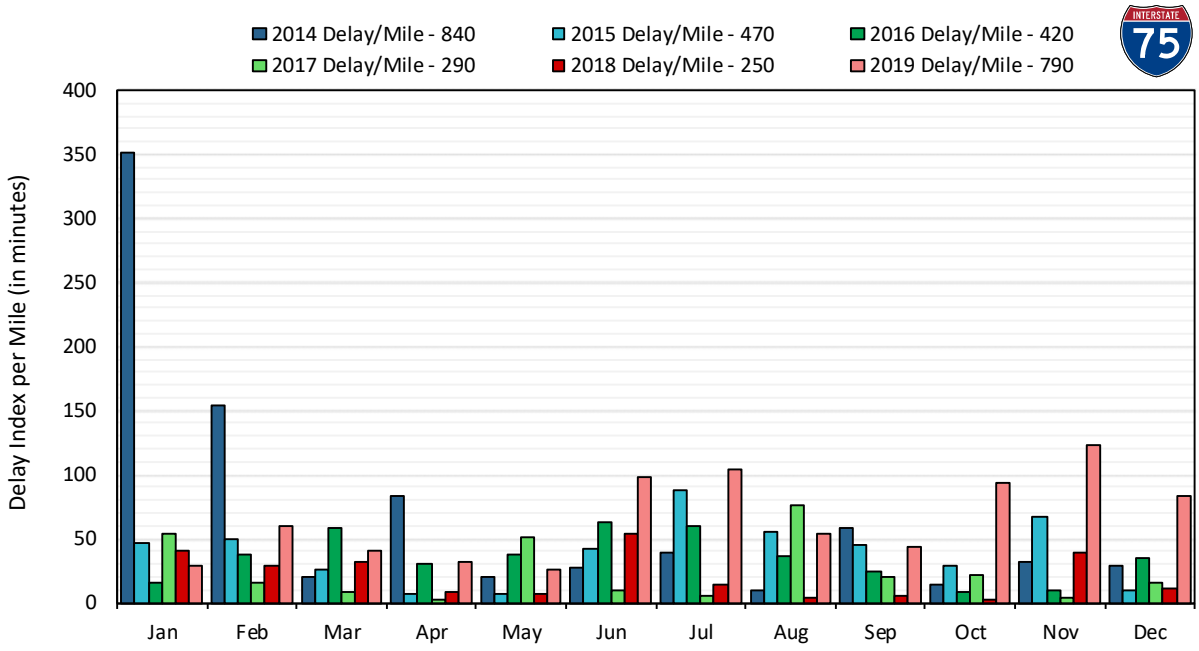


FIGURE 20. University Region Westbound I-69 Level of Travel Time Reliability

I-75: MONROE COUNTY DELAY INDEX



a) Segment Map



b) Delay Index Graph

FIGURE 21. Monroe County I-75 Corridor Delay Index

I-75: AVERAGE SPEED

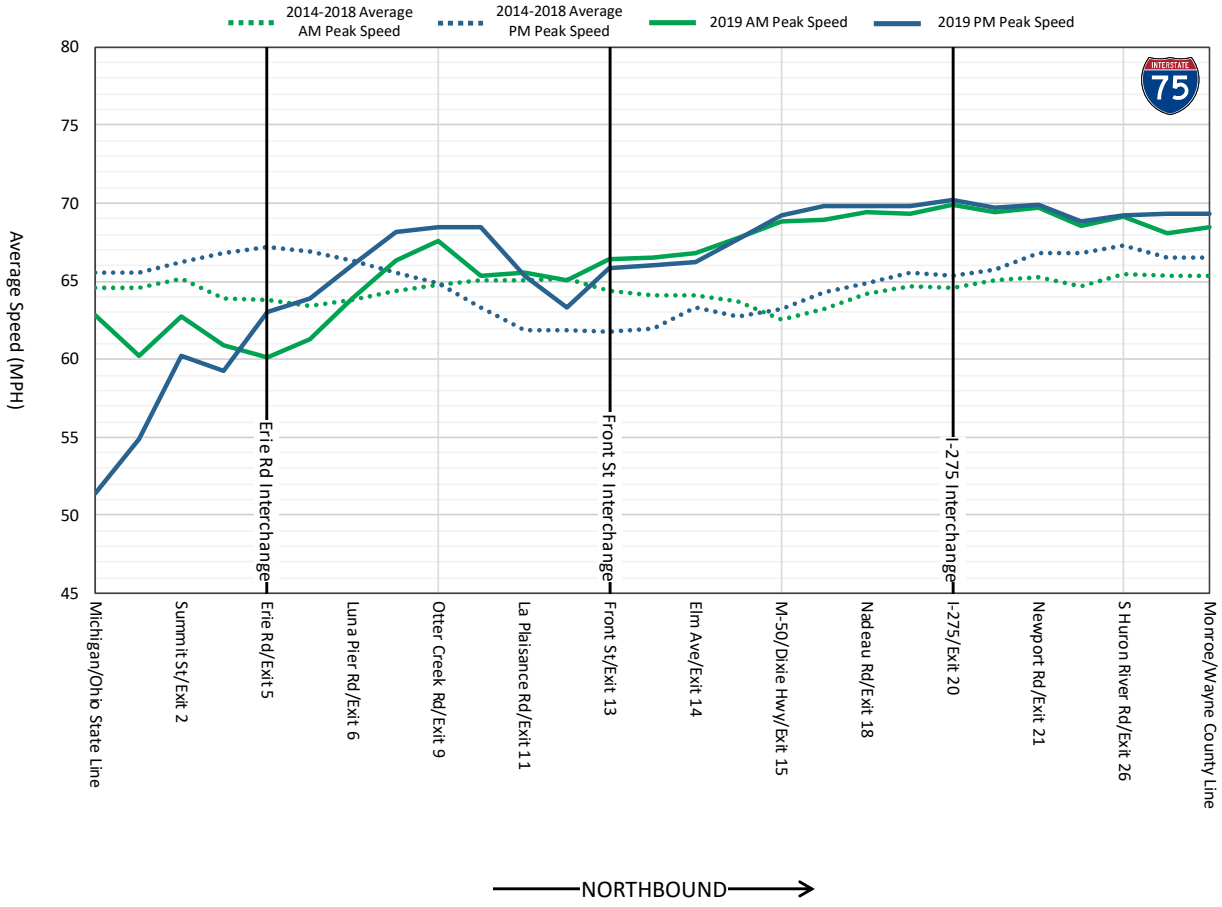


FIGURE 22. University Region Northbound I-75 Average Speed

I-75: AVERAGE SPEED

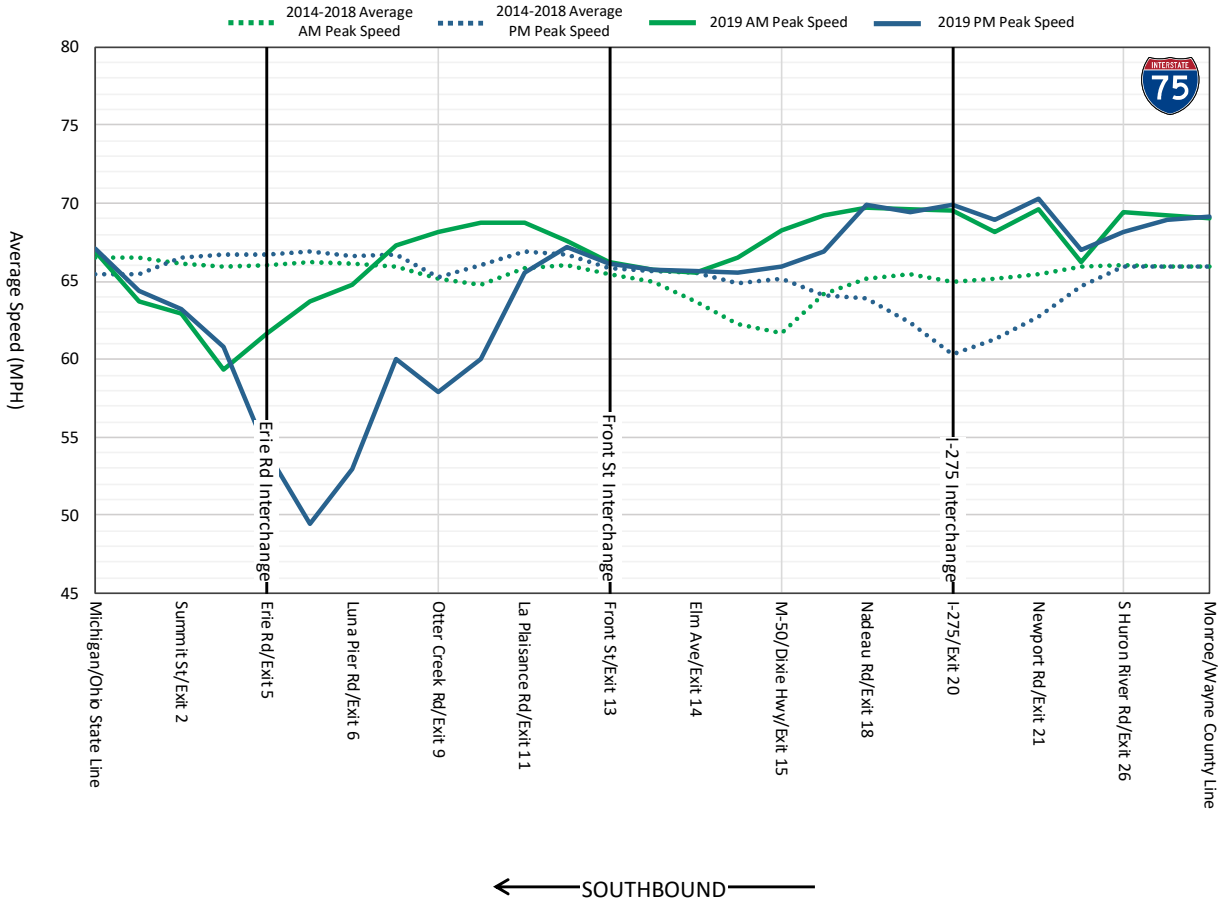


FIGURE 23. University Region Southbound I-75 Average Speed

I-75: LEVEL OF TRAVEL TIME RELIABILITY

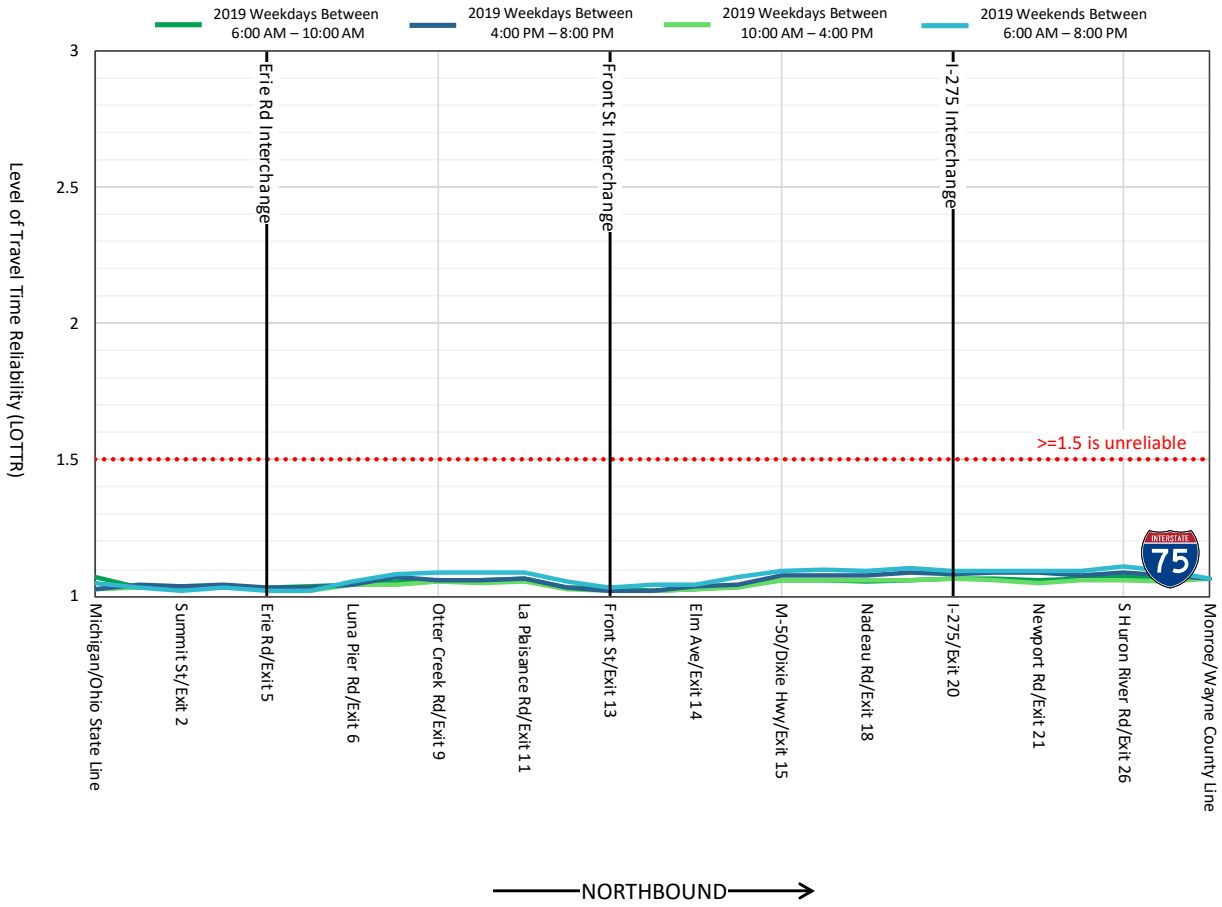


FIGURE 24. University Region Northbound I-75 Level of Travel Time Reliability

I-75: LEVEL OF TRAVEL TIME RELIABILITY

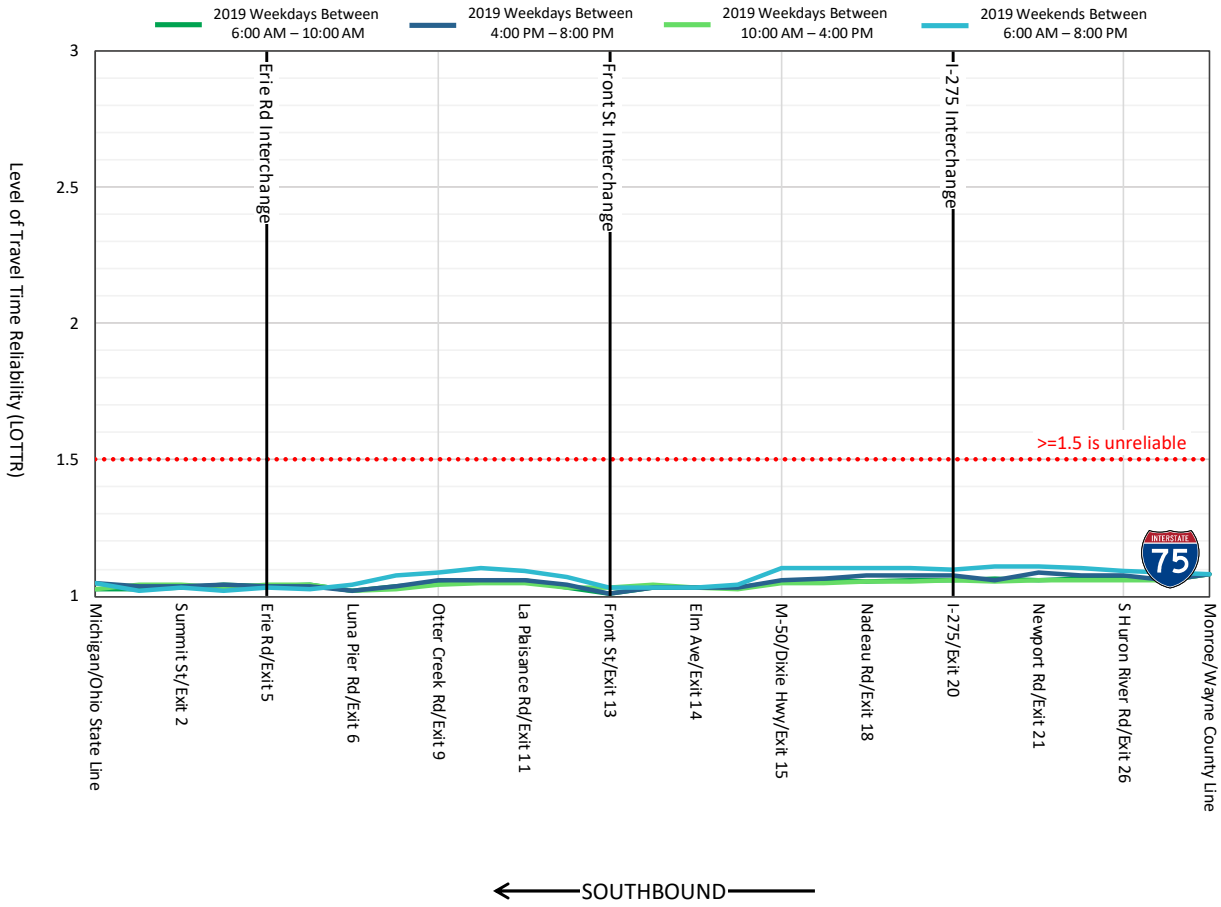
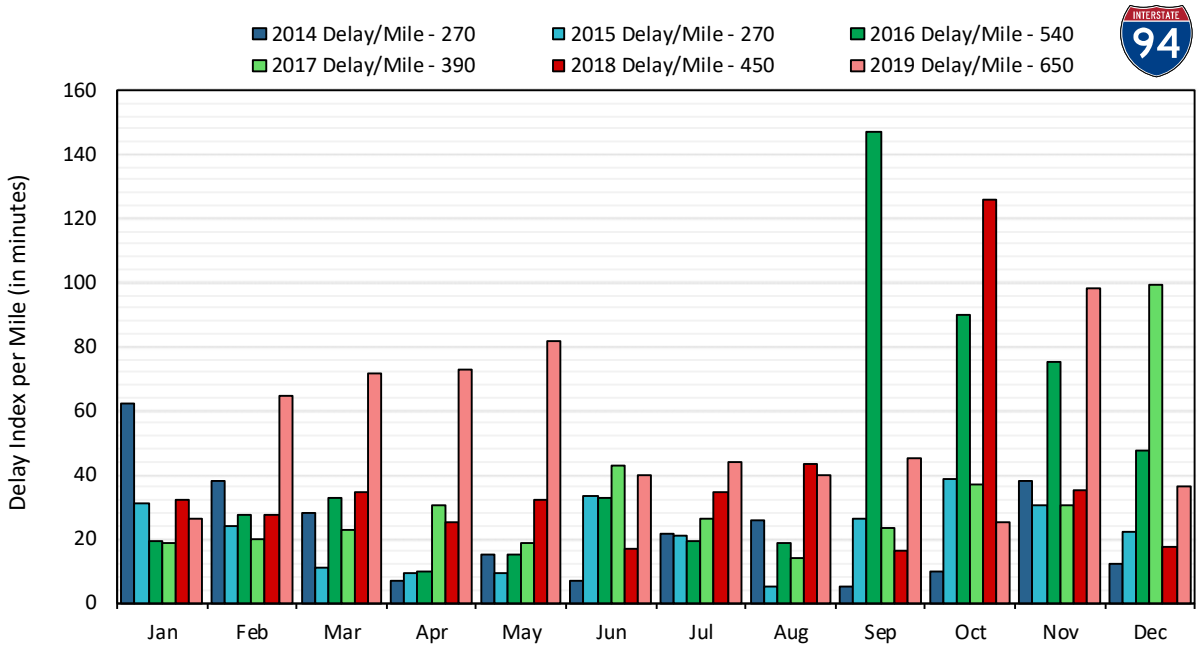


FIGURE 25. University Region Southbound I-75 Level of Travel Time Reliability

I-94: JACKSON COUNTY DELAY INDEX

a) Segment Map

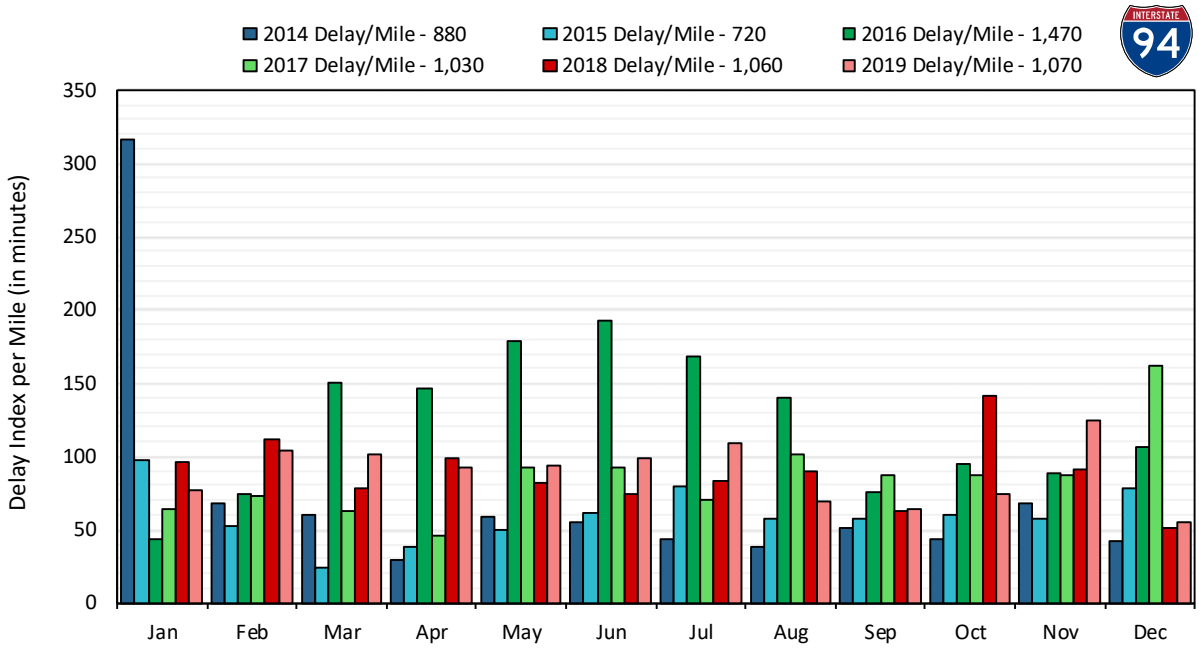


b) Delay Index Graph

FIGURE 26. Jackson County I-94 Corridor Delay Index

I-94: WASHTENAW COUNTY DELAY INDEX

a) Segment Map



b) Delay Index Graph

FIGURE 27. Washtenaw County I-94 Corridor Delay Index

I-94: AVERAGE SPEED

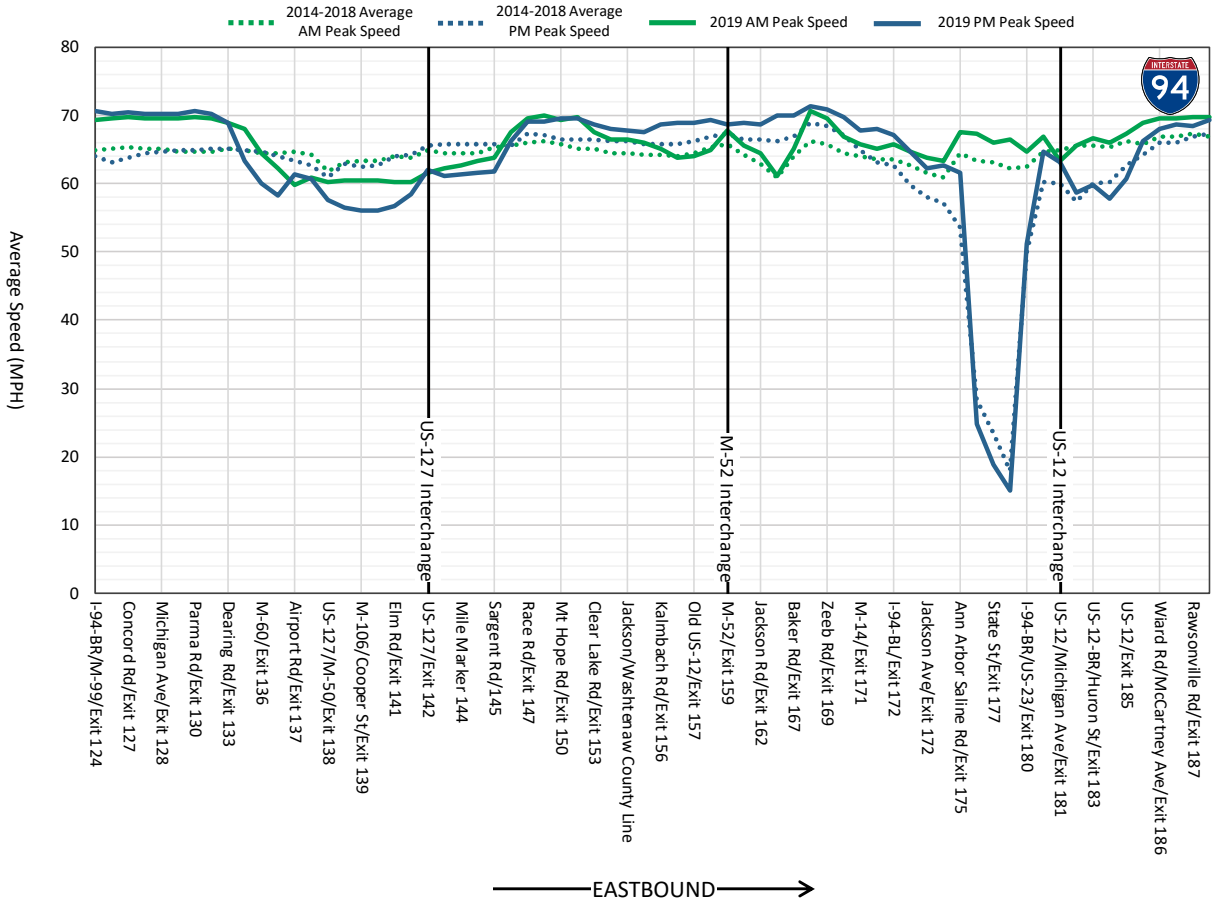


FIGURE 28. University Region Eastbound I-94 Average Speed

I-94: AVERAGE SPEED

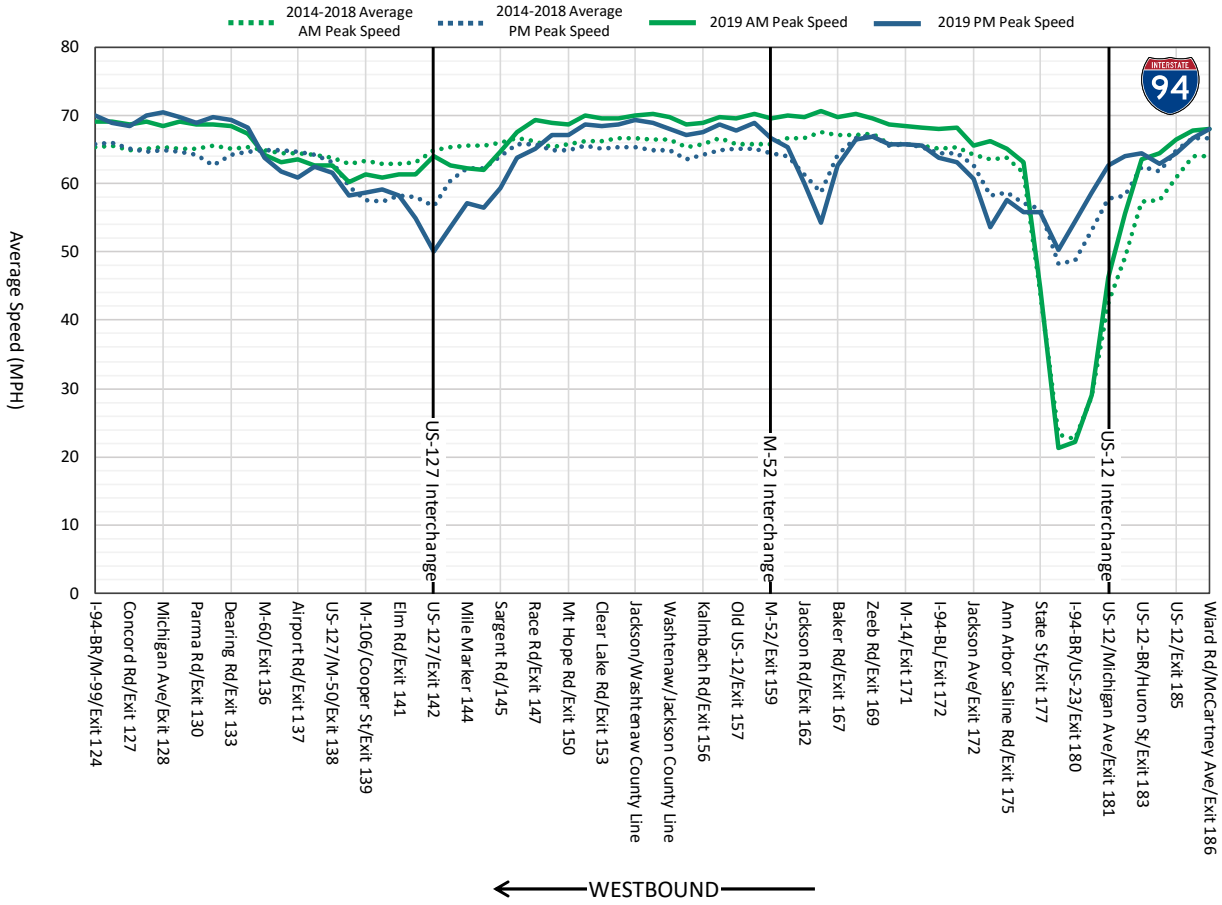
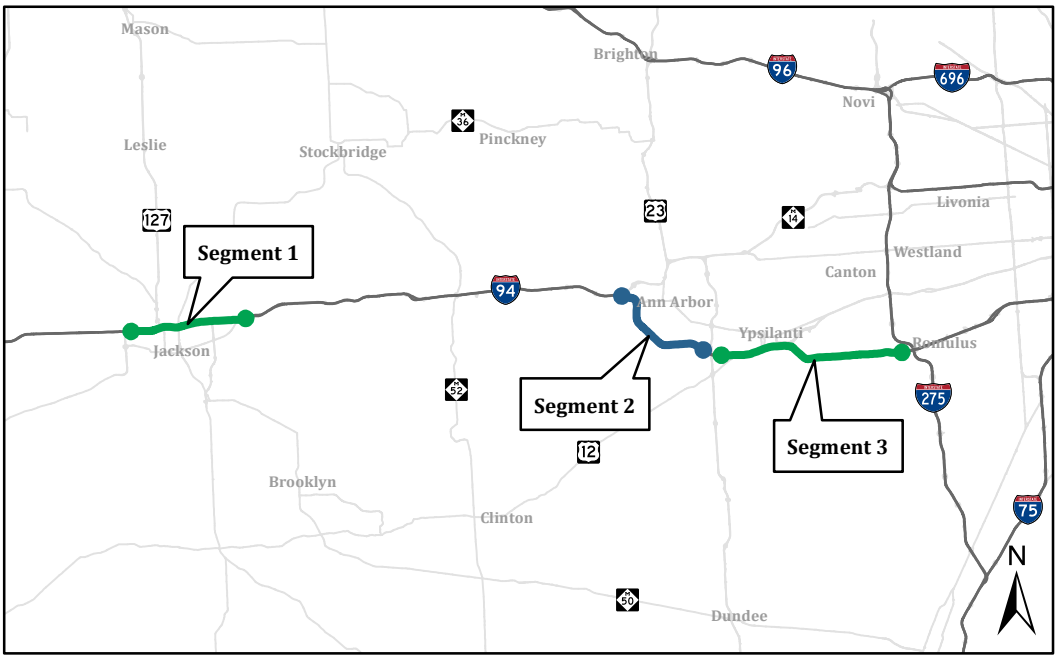


FIGURE 29. University Region Westbound I-94 Average Speed

I-94: TRAVEL TIME RELIABILITY

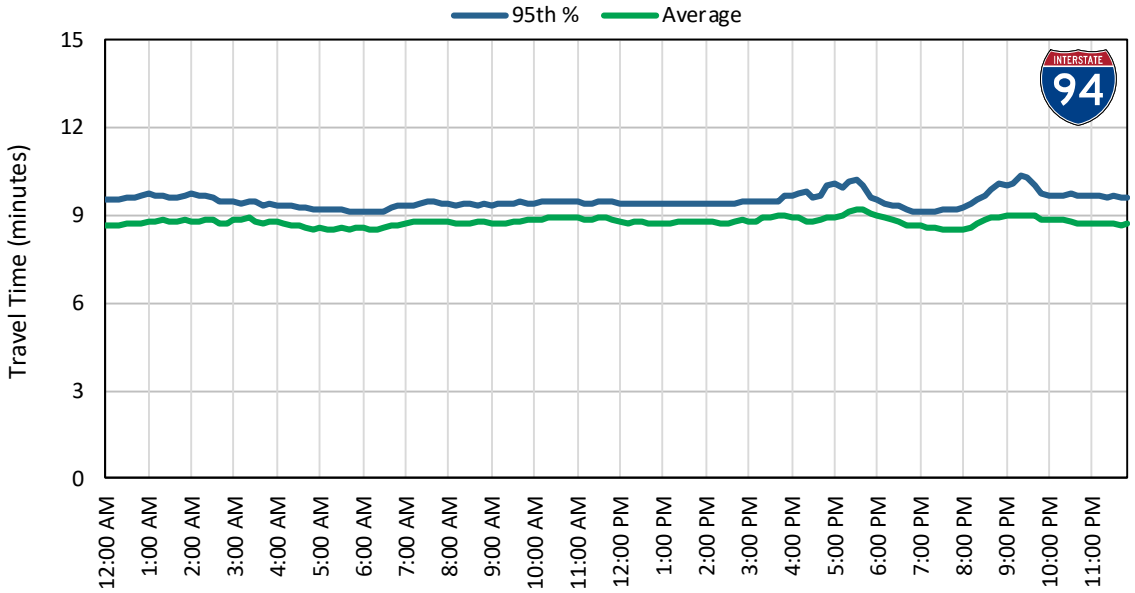
a) University Region and Wayne County



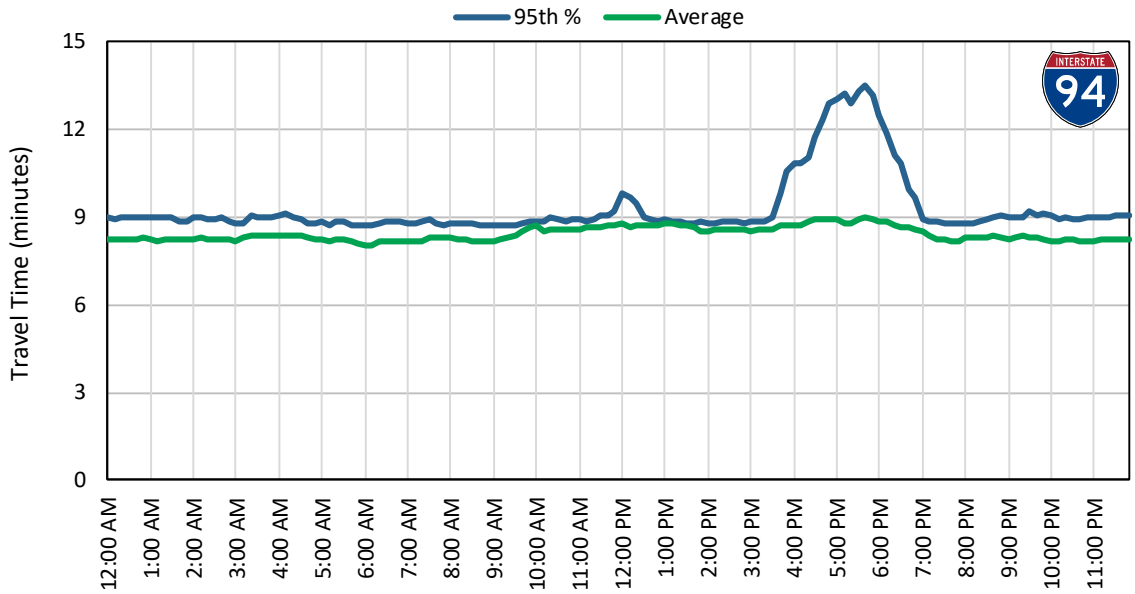
b) Jackson, Michigan and Ann Arbor, Michigan

FIGURE 30. Travel Time Reliability: I-94

I-94: TRAVEL TIME RELIABILTY



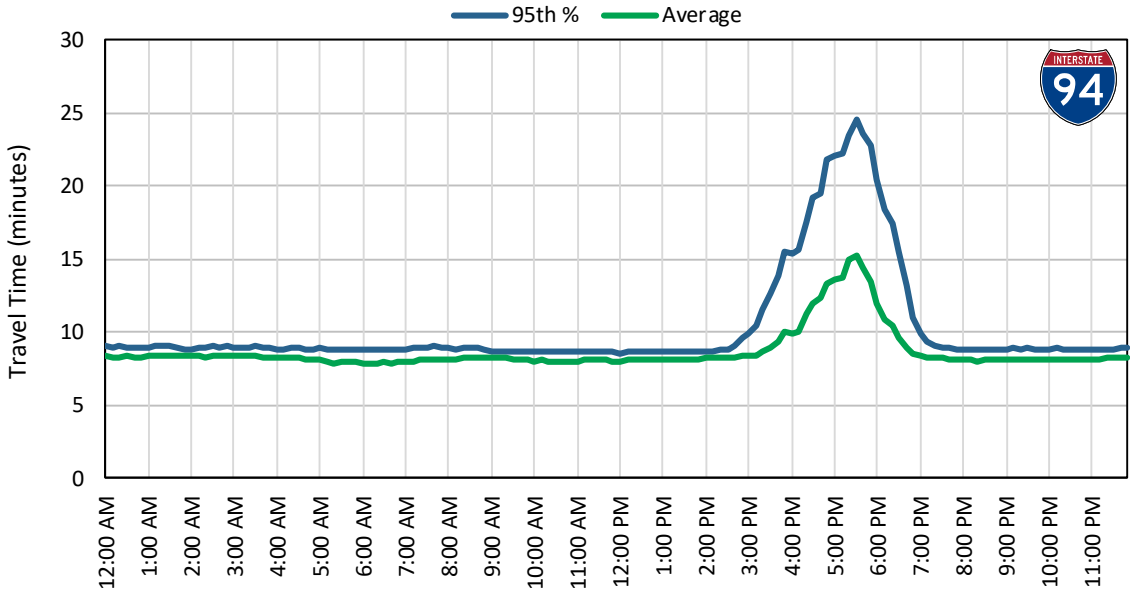
a) Eastbound



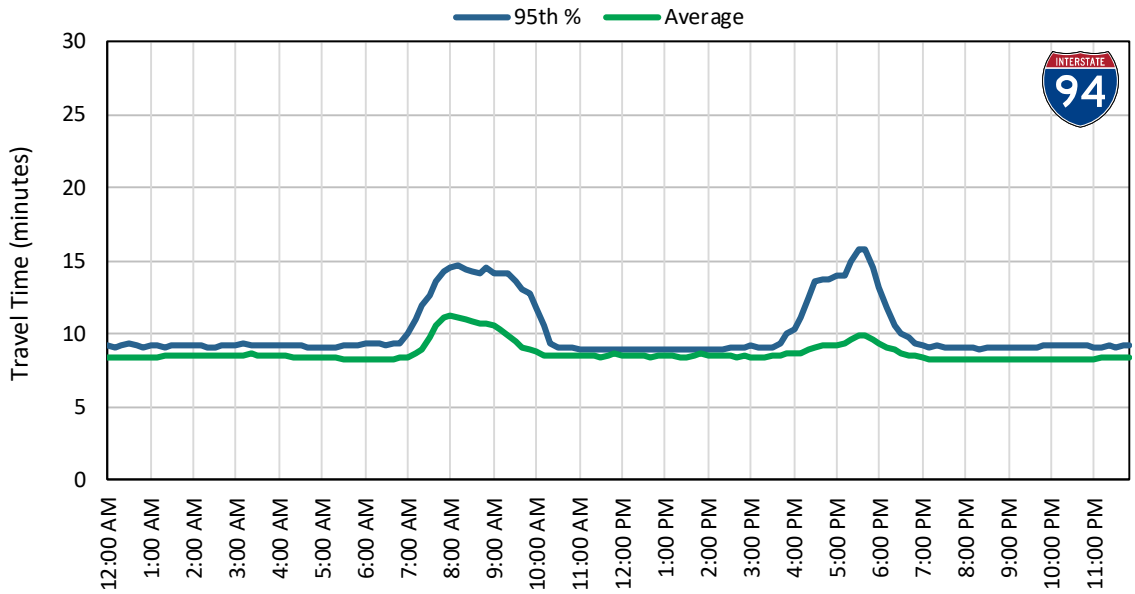
b) Westbound

FIGURE 31. Segment 1 - I-94 between M-60/Exit 136 and Sargent Rd/Exit 145

I-94: TRAVEL TIME RELIABILTY



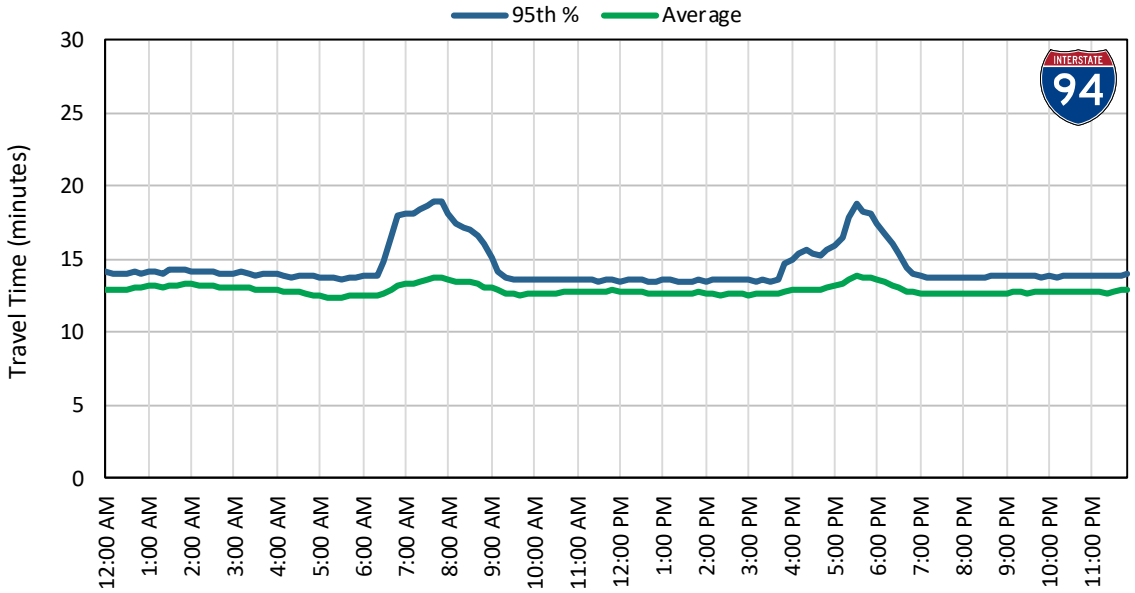
a) Eastbound



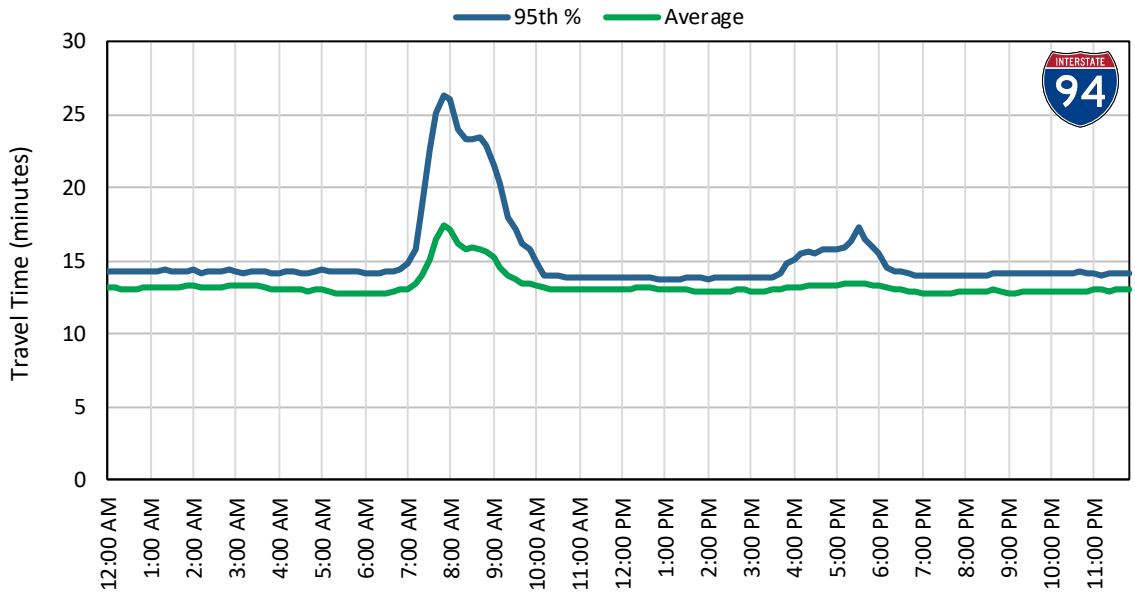
b) Westbound

FIGURE 32. Segment 2 - I-94 between M-14/Exit 171 and I-94/US-23/Exit 180

I-94: TRAVEL TIME RELIABILTY



a) Eastbound



b) Westbound

FIGURE 33. Segment 3 - I-94 between I-94/US-23/Exit 180 and I-275/Exit 194

I-94: LEVEL OF TRAVEL TIME RELIABILITY

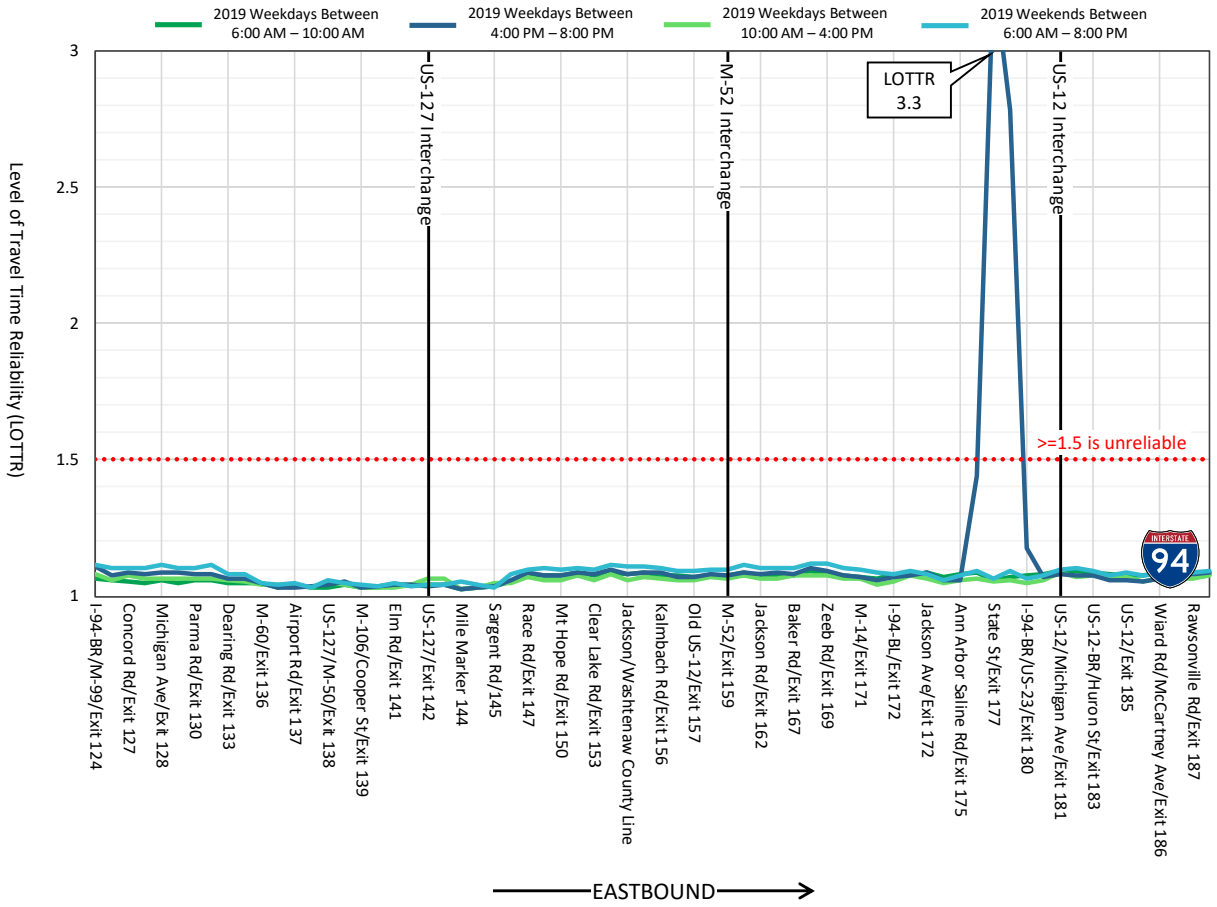


FIGURE 34. University Region Eastbound I-94 Level of Travel Time Reliability

I-94: LEVEL OF TRAVEL TIME RELIABILITY

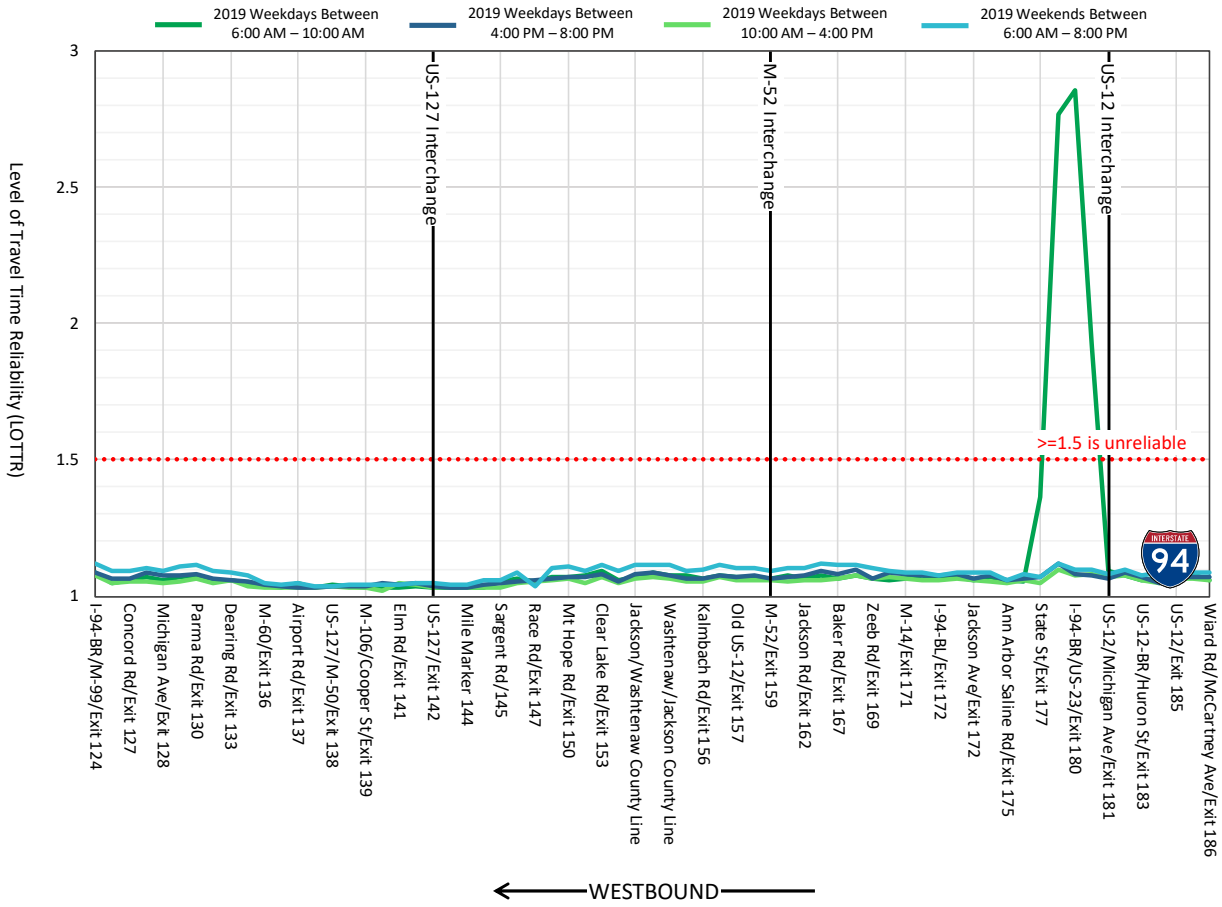
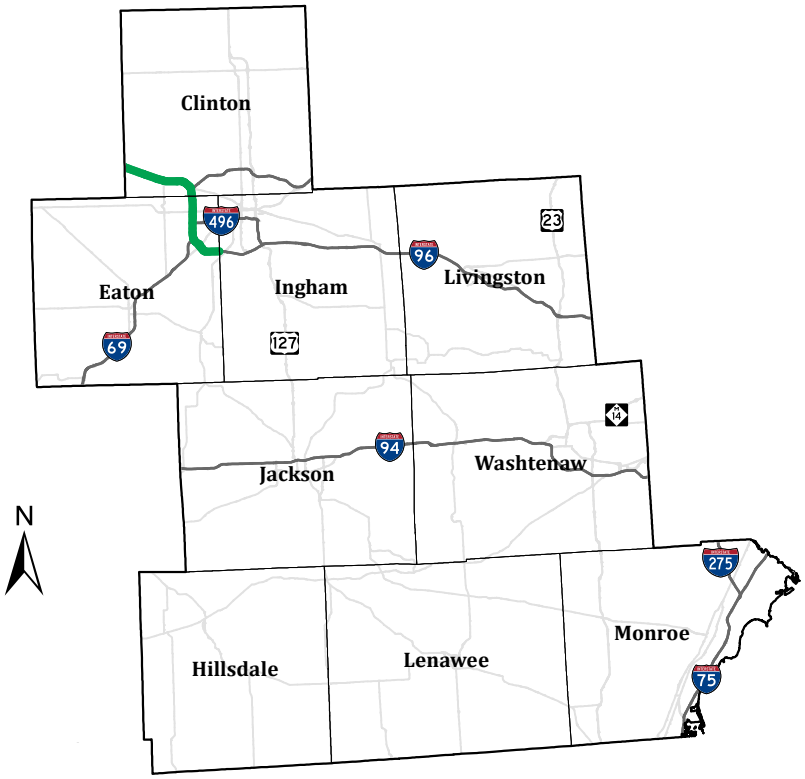
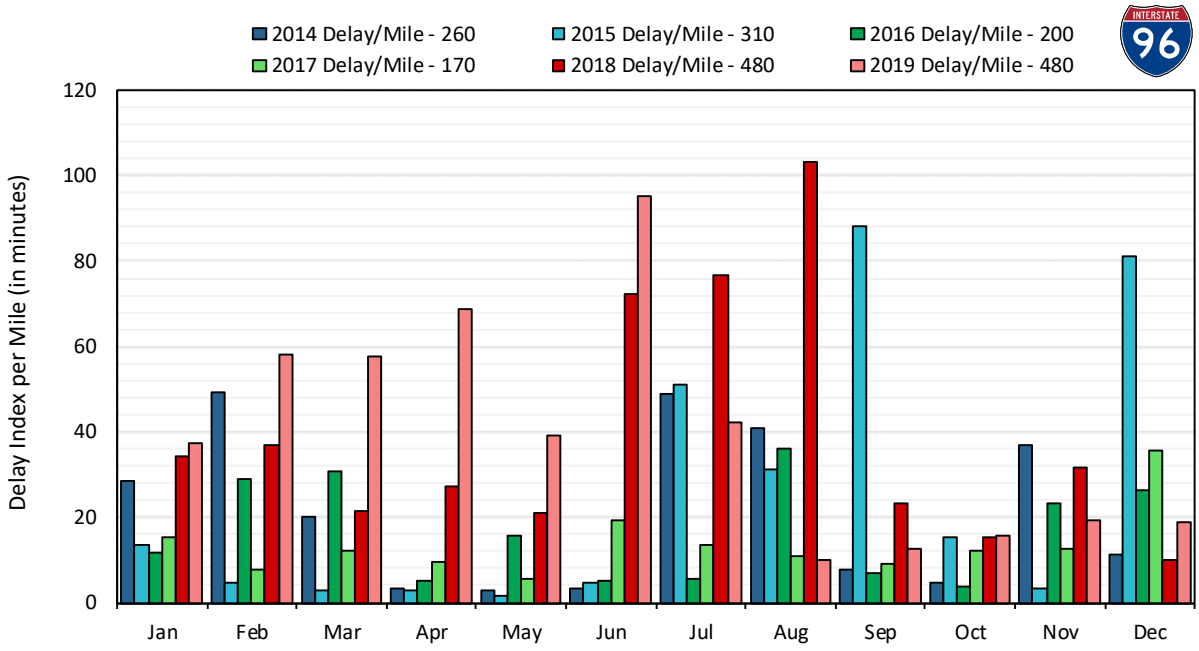


FIGURE 35. University Region Westbound I-94 Level of Travel Time Reliability

I-96: CLINTON AND EATON COUNTY DELAY INDEX



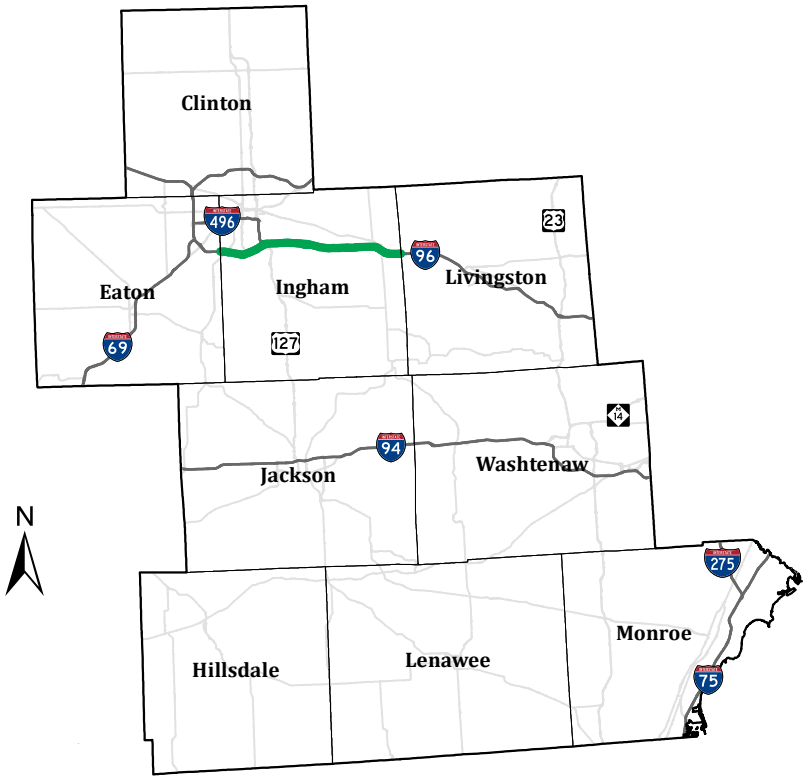
a) Segment Map



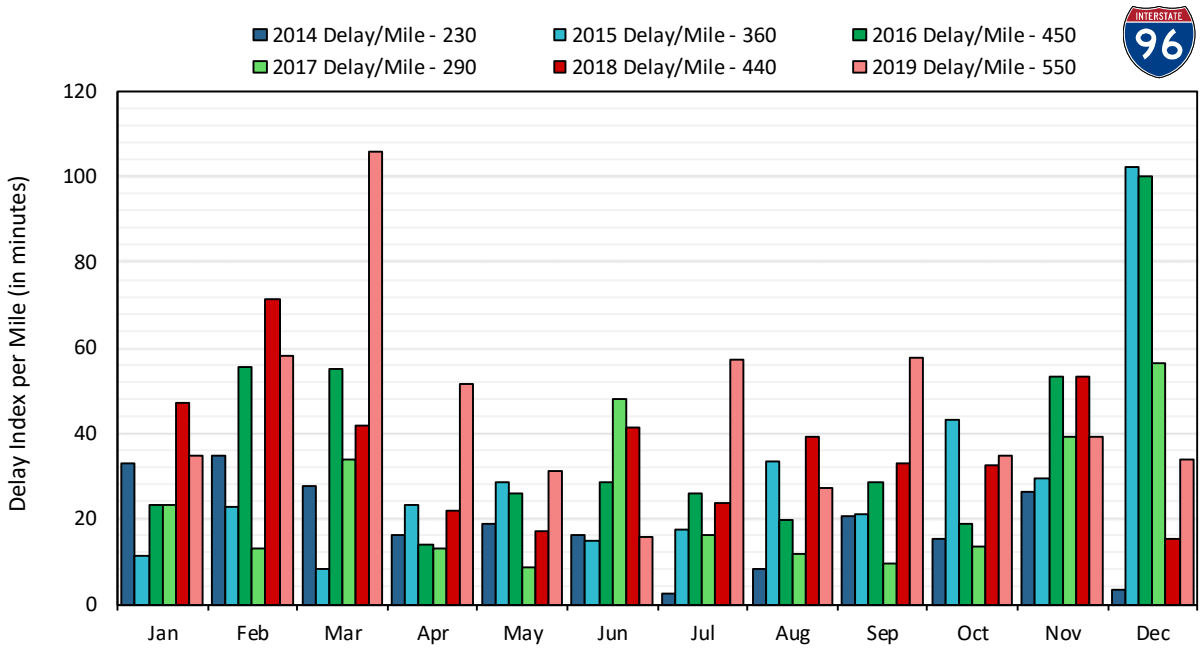
b) Delay Index Graph

FIGURE 36. Clinton and Eaton County I-96 Corridor Delay Index

I-96: INGHAM COUNTY DELAY INDEX



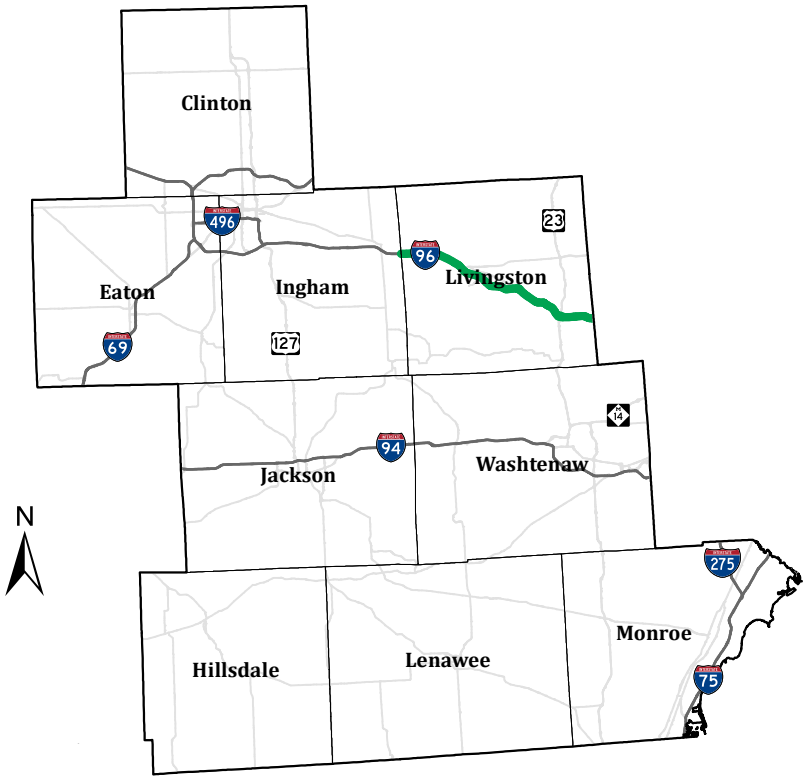
a) Segment Map



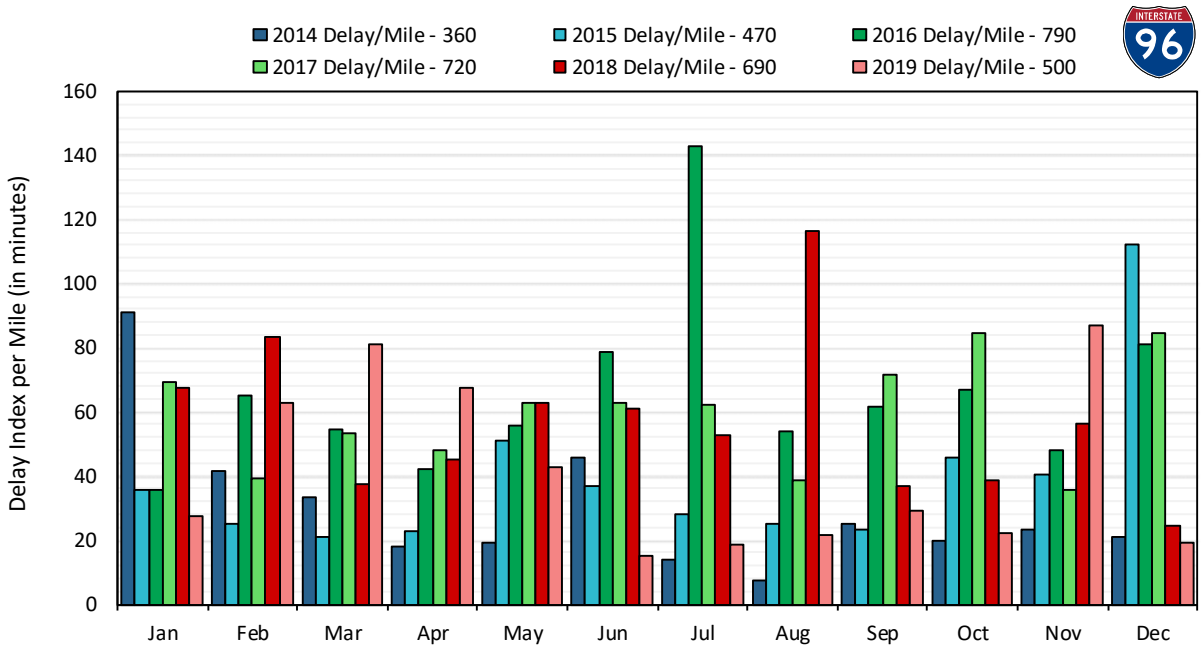
b) Delay Index Graph

FIGURE 37. Ingham County I-96 Corridor Delay Index

I-96: LIVINGSTON COUNTY DELAY INDEX



a) Segment Map



b) Delay Index Graph

FIGURE 38. Livingston County I-96 Corridor Delay Index

I-96: AVERAGE SPEED

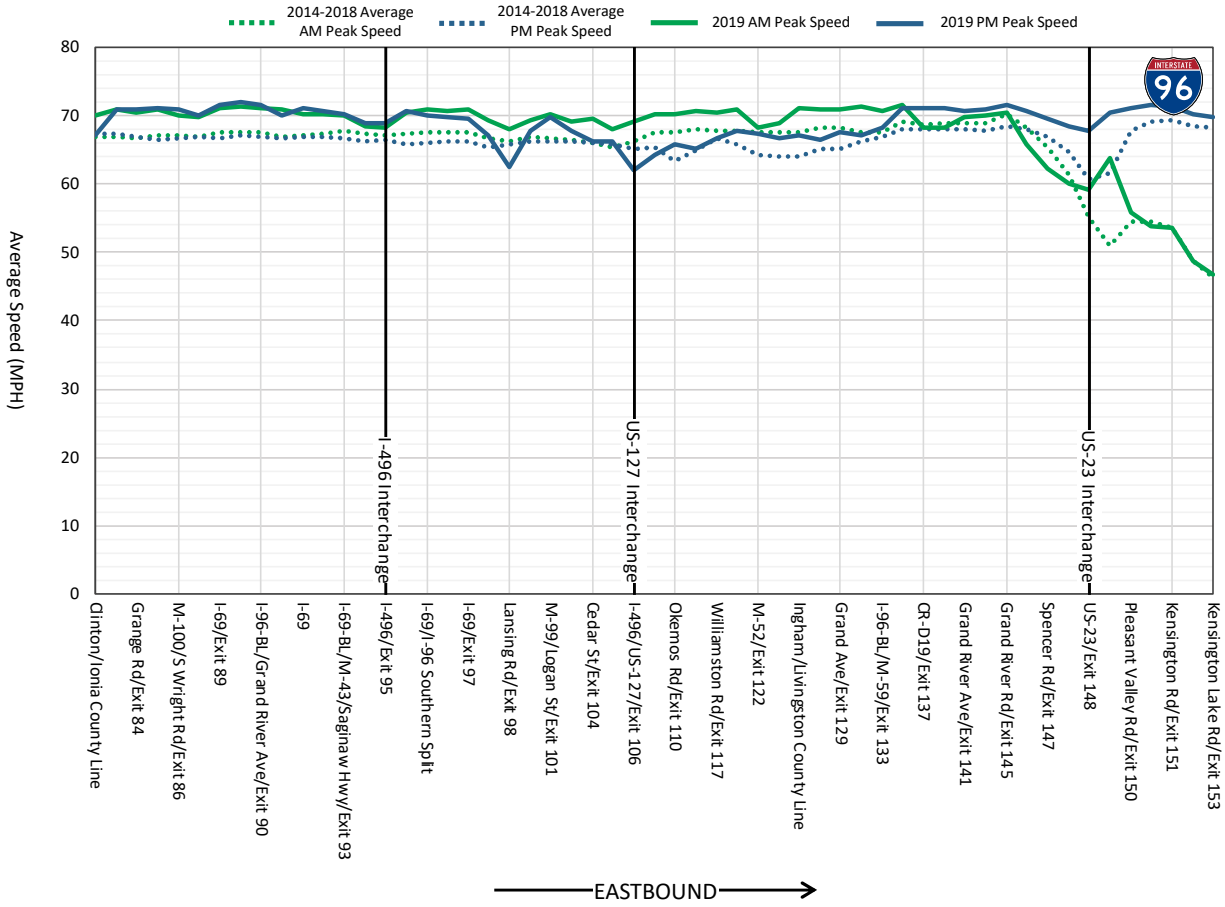


FIGURE 39. University Region Eastbound I-96 Average Speed